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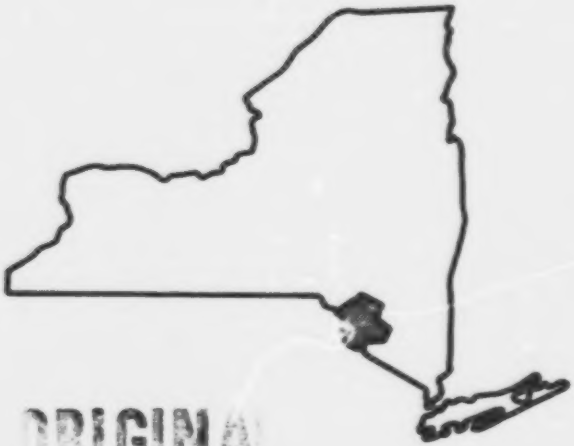
FLOOD INSURANCE STUDY

TOWN OF ROCKLAND, NEW YORK
SULLIVAN COUNTY



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DECEMBER 17, 1987

Federal Emergency Management Agency

COMMUNITY NUMBER - 360829

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NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program (NFIP) have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

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PUBLISHED SEPARATELY:

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FLOOD INSURANCE STUDY
TOWN OF ROCKLAND, NEW YORK

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Town of Rockland, Sullivan County, New York, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in their efforts to promote sound flood plain management. Minimum flood plain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were prepared by McFarland-Johnson Engineers, Inc., for the Federal Emergency Management Agency (FEMA), under Contract No. EMW-C-0730. This work was completed in June 1985.

1.3 Coordination

Streams requiring detailed study were identified at an initial Consultation and Coordination Officer's (CCO) meeting attended by representatives of FEMA, the Town of Rockland, and McFarland-Johnson Engineers, Inc. (the study contractor). Community officials and residents were requested to furnish all relevant flood hazard data.

On February 24, 1983, August 1, 1984, and February 20, 1985, the progress of the study was reviewed at intermediate CCO meetings held with representatives of the town, the New York State Department of Environmental Conservation, and the study contractor. On February 19, 1986, the results of the study were reviewed at a final CCO meeting attended by representatives of FEMA, the town, and the study contractor.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the Town of Rockland, Sullivan County, New York. The area of study is shown on the Vicinity Map (Figure).

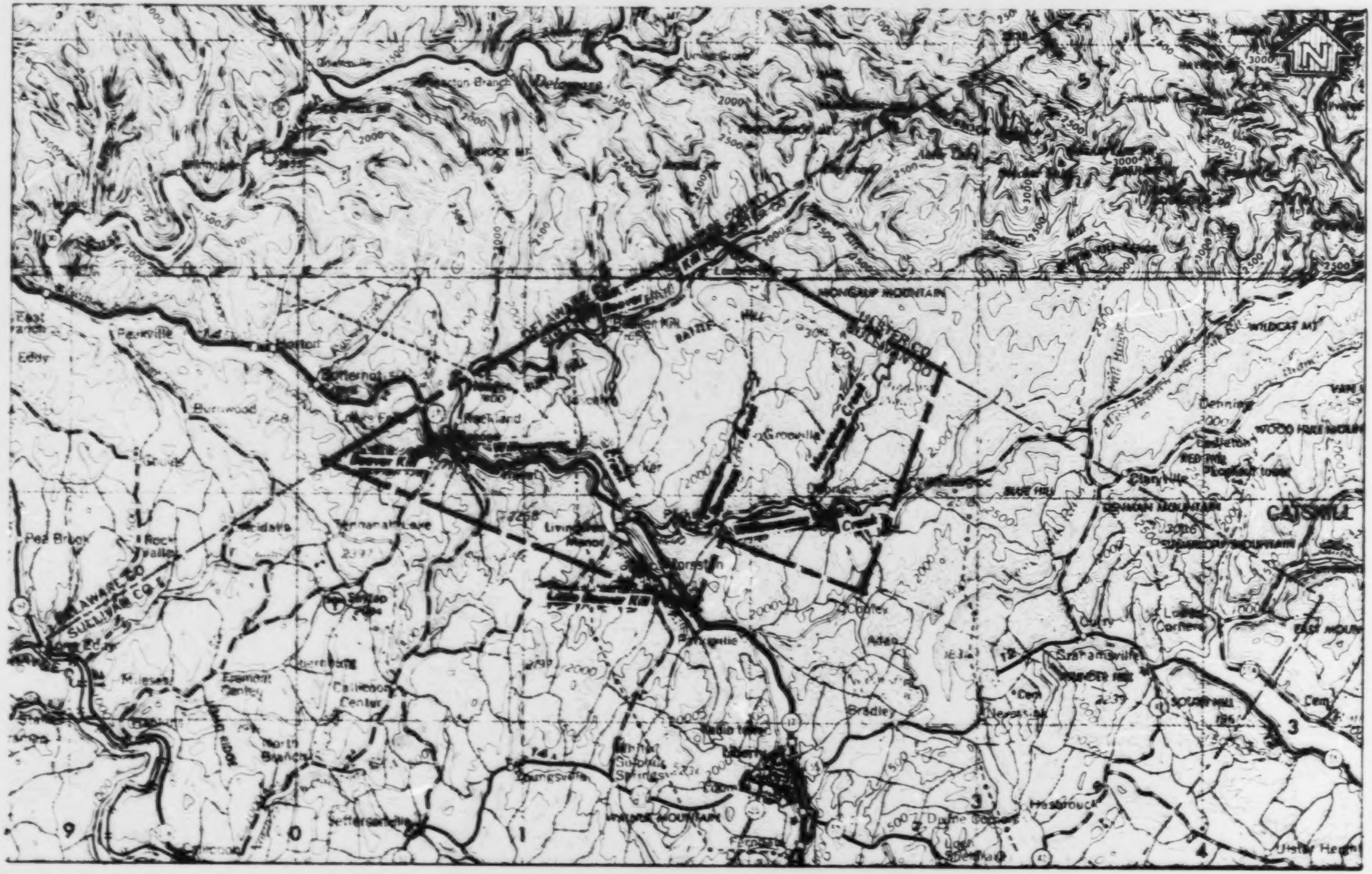
The following streams were studied by detailed methods: Willowemoc Creek from its confluence with Beaver Kill to approximately 1,050 feet upstream of Parkston Road; Beaver Kill from the confluence of Willowemoc Creek to the nearest upstream corporate limits; Stewart Brook from its confluence with Willowemoc Creek to a point approximately 9,000 feet upstream; Cattail Brook from its confluence with Willowemoc Creek to a point approximately 1,200 feet upstream of the Shandelle Road bridge; Little Beaver Kill from its confluence with Willowemoc Creek to the nearest upstream corporate limits; and Sprague Brook from its confluence with Willowemoc Creek to a point approximately 7,000 feet upstream. A ponding area north of Willowemoc Creek from approximately 800 feet upstream of Broad Street to approximately 1,000 feet downstream of Broad Street and sheet flow areas north of Little Beaver Kill from approximately 1,040 feet upstream of Grove Street to approximately 1,250 feet downstream of Grove Street were also studied by detailed methods. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction through June 1990.

Lily Pond and portions of Willowemoc Creek, Beaver Kill, Stewart Brook, Cattail Brook, and Sprague Brook were studied by approximate methods. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and the Town of Rockland.

2.2 Community Description

The Town of Rockland is located in the northern portion of Sullivan County in southeastern New York, approximately 70 miles southeast of the City of Binghamton and 120 miles northwest of New York City. It is bordered by the Town of Colchester to the northwest, the Town of Hardenburgh to the northeast, the Towns of Fremont and Callicoon to the southwest, the Town of Liberty to the south, and the Town of Neversink to the east.

Rockland was incorporated on April 10, 1810. Since the turn of the century, the town has become well known as an outdoor recreational community. The area offers outstanding recreational facilities for



N
DELAWARE CO.
SULLIVAN CO.
ULSTER CO.
Rockland
Beaver Kill
Livingston Manor
Roscoe
Parksville
Liberty
Grooville
Denning
Claryville
DENMAN MOUNTAIN
CATSKILL
Grahamsville
WILDCAT MT
Little Beaver Kill
East Branch
Delaware
Downsville
Hancock
Burnwood
Youngsville
Jeffersonville
Loch Sheldrake
Hasbrouck
Ulster Heights
Lew Beach
Sundown
Neversink
Bradley
Ferndale

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY

(SULLIVAN CO.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

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freshwater fishing, hunting, hiking, and summer camps. A large percentage of the local businesses (restaurants, lodges, motels, etc.) are geared to support vacationers, tourists, and sportsmen that visit the area from spring through fall. Additional sources of the town's economic base include a poultry processing plant, several sizable lumber yards and mills, and a large market for summer vacation homes.

The 1980 population of Rockland was 4,207, a 7.3-percent increase from 1970 (Reference 1). The majority of the population is centered around the Village of Roscoe, which is located at the confluence of Willowemoc Creek and Beaver Kill, and Livingston Manor, which is located at the confluence of Willowemoc Creek and Little Beaver Kill. Based on the gradual population growth rate through the 1970s, it is anticipated that the population of Rockland will continue to increase gradually in the future.

The climate of the town is characterized by cold snowy winters and generally warm, dry summers. The average monthly temperatures range from 24 degrees Fahrenheit (°F) in January to 67°F in July. The mean annual precipitation is approximately 46 inches (Reference 2).

The topography throughout Rockland is characterized by relatively narrow valleys and steep hilly uplands. With the exception of the more developed areas located in the valley sections, the majority of the land cover consists of heavy forest litter.

Beaver Kill and its tributary, Willowemoc Creek, are the principal streams in the town. Beaver Kill originates northeast of Rockland and flows southwest. Its drainage area at the downstream corporate limits of the town is 228 square miles, and the average stream slope in the study area is approximately 11 feet per mile. Willowemoc Creek generally flows west through the town to its confluence with Beaver Kill at Roscoe. The drainage area of Willowemoc Creek at its confluence is 129.7 square miles, and the average stream slope in the study area is 23 feet per mile.

Stewart Brook, Cattail Brook, Little Beaver Kill, and Sprague Brook are tributaries to Willowemoc Creek. The drainage areas of these streams at their confluence with Willowemoc Creek are 6.4, 6.9, 29.6, and 10.0 square miles, respectively.

Development within the flood plains of the principal streams in Rockland varies from farmland and widely dispersed homes to developed residential and commercial sections. The areas of highest development are generally located near the two population centers of Roscoe and Livingston Manor.

The majority of flooding in the Roscoe area results from backwater from Willowemoc Creek. Residential housing and commercial businesses in low-lying areas may be inundated. Additionally, several residential homes located to the north of the village and the Roscoe Motel lie within the flood plain of Beaver Kill.

In Livingston Manor, a large downtown area lies within the flood plains of Willowemoc Creek and Little Beaver Kill, including residential housing, commercial businesses, and a portion of the Livingston Manor Central School. Just upstream of Livingston Manor, the Willowemoc Motel is also located within the 100-year flood plain.

2.3 Principal Flood Problems

Willowemoc Creek is the major source of flooding within the Town of Rockland. The areas most frequently flooded are located in the Livingston Manor area. During the flood of July 1969, approximately 20 families living in the flood plain at Livingston Manor were forced to evacuate their homes. Additionally, a motel just outside of Livingston Manor was heavily damaged when Willowemoc Creek floodwaters inundated the first floor of the motel. Residents of several camps in the area were evacuated by boat because of the high water. The sewage treatment plant at Livingston Manor was also damaged by floodwaters (Reference 3).

During the winter and spring months, ice jams occasionally cause basement flooding along Little Beaver Kill immediately upstream of the Livingston Manor area and along Pleasant Street. The most notable location of ice jams are at the Main Street bridge over Little Beaver Kill in Livingston Manor.

Ice jams also are the cause of occasional flooding to a group of houses located on Yorktown Spur Road along Willowemoc Creek near the Roscoe area. Scattered flooding has also occurred within Roscoe due to Willowemoc Creek floodwaters passing through the Main Street underpass beneath State Route 17.

The flood of record for Willowemoc Creek as measured at the U. S. Geological Survey (USGS) gage at Livingston Manor occurred in July 1969. The measured peak discharge of 15,700 cubic feet per second (cfs) had an estimated recurrence interval of approximately 100 years. Otner notable floods at the gage occurred in March 1951 and December 1958.

The flood of record for Beaver Kill as measured at the USGS gage at Craigie Clair, New York, (located approximately 4.5 miles upstream of Roscoe) occurred in September 1942. The recorded peak discharge of

10,300 cfs had an estimated recurrence of approximately 25 years. Other notable floods at the Craigie Clair gage occurred in 1938, 1958, and 1969.

The USGS gaging station located approximately 2.8 miles upstream of Livingston Manor recorded the flood of record for Little Beaver Kill in August 1928. The recorded peak discharge was 3,420 cfs, with an estimated recurrence interval of approximately 25 years. Other floods on Little Beaver Kill, in order of magnitude, occurred in 1976, 1933, and 1936.

2.4 Flood Protection Measures

Prior to 1951, local interests with state and Works Progress Administration (WPA) aid constructed approximately 1,600 feet of masonry wall and 1,400 feet of low levee along the banks of Willowemoc Creek in Livingston Manor. Approximately 1,200 feet of the wall was built in front of the high school on the right bank of the creek. The levee on Willowemoc Creek was constructed downstream of this wall. In 1951, with state aid, approximately 1,000 feet of levee was constructed on the left bank of the creek below the confluence of Cattail Brook in Livingston Manor. Also in 1951, local interests at Roscoe with state aid dredged obstructed deposits from the streambed at the confluence of Beaver Kill and Willowemoc Creek in an effort to improve flow conditions and backwater flood heights (Reference 4).

FEMA specifies that all levees must have a minimum of 3 feet freeboard against 100-year flooding to be considered a safe flood protection structure. The levees and walls in the Town of Rockland do not meet the FEMA freeboard requirement, and are not considered to be protection structures.

Rockland also utilizes non-structural measures of flood protection by adopting regulations to restrict and regulate development in the flood plains.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied in detail affecting the community.

Discharges for the 10-, 50-, 100-, and 500-year floods for Willowemoc Creek, Beaver Kill, and Little Beaver Kill were computed using a regional method developed by the USGS and flood-frequency analyses of gaging station records (Reference 5). The USGS method, primarily used for ungaged sites, is based on regression equations developed using flood-frequency estimates and basin characteristics of a large number of gaging stations in southeastern New York.

Gaging stations along Willowemoc Creek (No. 01419500) and along Little Beaver Kill (No. 01420000) are located within the study area. There are also two gaging stations (Nos. 01418500 and 01420500) along Beaver Kill above and below the study area, respectively. The records of these gages vary from a minimum of 37 years to a maximum of 62 years. The flood-frequency analyses for all gages were performed in accordance with guidelines presented by the Water Resources Council (Reference 6). The discharge estimates computed from the regression equations were verified by transferring the discharge-frequency analysis from gages to ungaged sites using procedures outlined by the USGS method (Reference 5).

Discharges for Stewart Brook, Cattail Brook, and Sprague Brook were computed using the regional method developed by the USGS (Reference 5). The validity of the discharges computed by the method was verified by transposing flood-frequency data from a nearby gaged watershed of similar hydrologic characteristics to the point of interest by the following equation:

where Q_p is the discharge at the point of interest, Q_G is the discharge at the gage, A_p is the drainage area at the point of interest, and A_G is the drainage area at the gage.

A summary of drainage area-peak discharge relationships for the streams studied by detailed methods is shown in Table 1, "Summary of Discharges."

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
WILLOWEMOC CREEK					
Above the confluence with Beaver Kill	129.7	12,300	21,000	25,900	37,800
Above the confluence of Hazel Brook	113.2	11,350	19,400	23,750	35,250
Above the confluence of Little Beaver Kill	64.0	7,330	12,900	16,000	24,000
Above the confluence of Sprague Brook	50.1	5,950	10,430	12,885	19,335
BEAVER KILL					
Above the confluence of Willowemoc Creek	98.3	8,345	13,660	16,400	23,500
STEWART BROOK					
At its confluence with Willowemoc Creek	6.4	800	1,330	1,600	2,285
CATTAIL BROOK					
At its confluence with Willowemoc Creek	6.9	890	1,485	1,790	2,580
LITTLE BEAVER KILL					
At its confluence with Willowemoc Creek	29.6	3,225	5,275	6,345	9,100
Above the State Route 146 crossing	24.5	2,895	4,730	5,685	8,100
Above gaging station	19.8	2,450	3,985	4,780	6,800
SPRAGUE BROOK					
At its confluence with Willowemoc Creek	10.0	1,370	2,435	3,000	4,500

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Overbank data for the cross sections were obtained from topographic maps compiled from aerial photographs (Reference 7). Data for the below-water sections were field surveyed. Cross sections were located at regular intervals warranted by topographic changes and at close intervals upstream and downstream of bridges in order to compute the backwater effects of the structures. Elevation data and structural geometry for all bridges were also field surveyed.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Water-surface elevations of floods of the selected recurrence intervals were computed using the U. S. Army Corps of Engineers (COE) HEC-2 step-backwater computer program (Reference 8). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. Starting water-surface elevations for Beaver Kill, Stewart Brook, Cattail Brook, Little Beaver Kill, and Sprague Brook were determined by the slope/area method. Starting water-surface elevations for Willowemoc Creek were obtained using coincidental flooding with Beaver Kill.

Channel roughness coefficients (Manning's "n") used in the hydraulic computations were estimated by field inspection and engineering judgment (References 9 and 10). The channel "n" and overbank "n" values for the streams studied by detailed methods are shown in the following tabulation:

Stream	Channel "n"	Overbank "n"
Willowemoc Creek	0.032-0.055	0.055-2.000
Beaver Kill	0.037-0.051	0.045-0.750
Stewart Brook	0.040-0.061	0.060-0.120
Cattail Brook	0.048-0.061	0.040-0.150
Little Beaver Kill	0.045-0.060	0.055-3.000
Sprague Brook	0.046-0.054	0.060-0.150

A volume-depth relationship was used to determine the water-surface elevation for the ponding area north of Willowemoc Creek. A weir equation was used to determine the depth of the sheet flow areas north of Little Beaver Kill.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the maps.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

For the flooding sources studied by approximate methods, the 100-year flood elevations were determined from flood height versus drainage area curves for the Delaware River basin as developed by the USGS (Reference 11).

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages State and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing flood plain management measures.

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for flood plain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year flood plain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps (Reference 7).

For the flooding sources studied by approximate methods, the boundary of the 100-year flood was delineated using USGS topographic maps (Reference 12).

The 100- and 500-year flood plain boundaries are shown on the Flood Boundary and Floodway Map (Exhibit 2). In cases where the 100- and 500-year flood plain boundaries are close together, only the 100-year flood plain boundary has been shown. Small areas within the flood plain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

Encroachment on flood plains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood plain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent flood plain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the flood plain. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 2).

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the floodway and 100-year flood plain boundaries are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and 100-year flood plain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain developments are shown in Figure 2.

Near the mouths of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, "Without Floodway" elevations presented in Table 2 for certain downstream cross sections of Willowemoc Creek are lower than the regulatory flood elevations in that area, which must take into account the 100-year flooding due to backwater from other sources.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Willowemoc Creek								
A	220	450	3,732	6.9	1,277.0	1,276.5[2]	1,277.5	1.0
B	520	209	2,526	10.3	1,277.0	1,277.0	1,278.0	1.0
C	2,550	362	4,824	5.4	1,288.7	1,288.7	1,299.4	0.7
D	4,070	545	4,295	6.0	1,292.0	1,292.0	1,292.9	0.9
E	7,460	150	2,529	10.2	1,307.7	1,307.7	1,307.7	0.0
F	9,020	150	2,221	11.7	1,311.7	1,311.7	1,312.2	0.5
G	10,020	237	2,928	8.8	1,315.7	1,315.7	1,316.1	0.4
H	12,310	143	2,530	10.2	1,330.2	1,330.2	1,331.0	0.8
I	12,830	118	2,245	11.5	1,331.9	1,331.9	1,332.7	0.8
J	14,670	555	5,535	4.7	1,337.2	1,337.2	1,338.0	0.8
K	16,090	298	1,823	13.0	1,340.6	1,340.6	1,341.3	0.7
L	17,890	267	2,196	10.8	1,349.5	1,349.5	1,350.3	0.8
M	19,640	328	3,522	6.7	1,357.1	1,357.1	1,357.5	0.4
N	22,050	169	3,229	7.4	1,366.6	1,366.6	1,367.6	1.0
O	23,530	433	5,350	4.4	1,370.2	1,370.2	1,371.1	0.9
P	25,310	422	3,751	6.3	1,372.2	1,372.2	1,373.0	0.8
Q	27,245	585	3,770	6.3	1,378.5	1,378.5	1,379.1	0.6
R	28,860	215	2,436	9.7	1,384.4	1,384.4	1,384.8	0.4
S	30,660	476	3,476	6.8	1,391.2	1,391.2	1,391.3	0.1
T	33,580	480	3,456	6.9	1,400.0	1,400.0	1,400.1	0.1
U	35,390	230	2,278	10.4	1,405.3	1,405.3	1,405.9	0.6
V	36,815	490	3,516	6.8	1,411.2	1,411.2	1,412.1	0.9
W	39,315	365	2,859	8.3	1,421.5	1,421.5	1,421.7	0.2
X	40,765	248	1,296	12.3	1,425.9	1,425.9	1,426.8	0.9

[1] Feet above confluence with Beaver Kill

[2] Elevation computed without consideration of backwater from Beaver Kill

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY

(SULLIVAN CO.)

FLOODWAY DATA

WILLOWEMOC CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Willowemoc Creek (continued)								
Y	41,525[1]	138	1,442	11.1	1,431.4	1,431.4	1,431.5	0.1
Z	43,110[1]	99	1,114	14.4	1,438.9	1,438.9	1,438.9	0.0
AA	44,530[1]	190	1,793	8.9	1,444.8	1,444.8	1,445.2	0.4
AB	45,950[1]	250	1,925	8.3	1,451.2	1,451.2	1,451.5	0.3
AC	47,850[1]	1,050	5,064	3.2	1,458.5	1,458.5	1,459.5	1.0
AD	49,380[1]	580	2,091	7.7	1,467.0	1,467.0	1,467.5	0.5
AE	50,600[1]	395	2,799	5.7	1,477.6	1,477.6	1,478.3	0.7
AF	53,640[1]	270	2,017	7.9	1,497.1	1,497.1	1,497.9	0.8
AG	55,030[1]	290	2,222	7.2	1,504.1	1,504.1	1,504.8	0.7
AH	57,310[1]	660	5,056	2.5	1,514.7	1,514.7	1,515.3	0.6
AI	59,670[1]	500	2,406	5.4	1,528.2	1,528.2	1,529.0	0.8
AJ	61,160[1]	174	918	14.0	1,539.2	1,539.2	1,539.5	0.3
AK	62,160[1]	400	2,784	4.6	1,546.6	1,546.6	1,547.2	0.6
Beaver Kill								
A	320[2]	445	4,789	3.4	1,277.9	1,277.9	1,278.9	1.0
B	930[2]	459	4,308	3.8	1,279.3	1,279.3	1,279.7	0.4
C	1,950[2]	455	2,932	5.6	1,280.0	1,280.0	1,280.8	0.8
D	3,750[2]	146	1,358	12.1	1,285.8	1,285.8	1,286.3	0.5
E	5,135[2]	545	4,071	4.0	1,292.0	1,292.0	1,293.0	1.0
F	6,655[2]	250	1,526	10.7	1,296.8	1,296.8	1,297.3	0.5
G	8,115[2]	200	1,807	9.1	1,306.5	1,306.5	1,306.7	0.2

[1] Feet above confluence with Beaver Kill

[2] Feet above confluence of Willowemoc Creek

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY

(SULLIVAN CO.)

FLOODWAY DATA

WILLOWEMOC CREEK - BEAVER KILL

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Stewart Brook								
A	1,224	78	212	7.6	1,300.8	1,300.8	1,300.9	0.1
B	1,804	35	200	8.0	1,307.6	1,307.6	1,308.2	0.6
C	2,914	60	257	6.2	1,322.5	1,322.5	1,322.9	0.4
D	4,364	38	195	8.2	1,333.5	1,333.5	1,334.5	1.0
E	5,524	113	239	6.7	1,346.6	1,346.6	1,346.8	0.2
F	6,499	105	271	5.9	1,358.1	1,358.1	1,358.7	0.6
G	7,434	120	361	4.4	1,370.5	1,370.5	1,371.3	0.8
H	8,354	97	286	5.6	1,383.8	1,383.8	1,384.3	0.5
Cattail Brook								
A	505	33	205	8.7	1,426.8	1,426.8	1,426.8	0.0
B	575	24	172	10.4	1,427.4	1,427.4	1,427.5	0.1
C	1,160	39	185	9.7	1,436.7	1,436.7	1,437.4	0.7
D	1,545	23	174	10.3	1,445.9	1,445.9	1,446.2	0.3
E	2,415	32	212	8.4	1,462.6	1,462.6	1,463.5	0.9
F	2,705	19	129	13.9	1,468.6	1,468.6	1,468.6	0.0
G	3,495	34	158	11.3	1,487.9	1,487.9	1,487.9	0.0
H	3,985	38	173	10.3	1,497.1	1,497.1	1,497.5	0.4
I	4,755	33	200	8.9	1,514.9	1,514.9	1,515.8	0.9

[1] Feet above confluence with Willowemoc Creek

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY
TOWN OF ROCKLAND, NY
(SULLIVAN CO.)

FLOODWAY DATA

STEWART BROOK AND CATTAIL BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
						(FEET NGVD)		
Little Beaver Kill								
A	400	110	996	6.4	1,421.6	1,421.6	1,422.6	1.0
B	800	179	628	10.1	1,423.3	1,423.3	1,423.8	0.5
C	3,312	815	6,597	1.0	1,427.0	1,427.0	1,428.0	1.0
D	5,312	593	3,254	1.9	1,428.0	1,428.0	1,428.9	0.9
E	7,332	415	1,445	4.4	1,442.3	1,442.3	1,443.0	0.7
F	9,272	135	917	6.9	1,456.4	1,456.4	1,456.8	0.4
G	10,562	150	943	6.0	1,466.9	1,466.9	1,466.9	0.0
H	12,527	226	763	7.5	1,479.8	1,479.8	1,480.8	1.0
I	13,537	300	1,754	3.2	1,486.8	1,486.8	1,487.7	0.9
J	14,537	54	508	11.2	1,491.9	1,491.9	1,492.5	0.6
K	16,160	225	1,288	4.4	1,502.6	1,502.6	1,503.3	0.7
L	16,970	320	680	7.0	1,506.1	1,506.1	1,506.2	0.1
Sprague Brook								
A	1,000	250	482	6.2	1,522.9	1,522.9	1,523.3	0.4
B	1,555	282	409	7.3	1,536.0	1,536.0	1,536.7	0.7
C	2,455	44	250	12.0	1,554.6	1,554.6	1,555.0	0.4
D	3,030	34	251	11.9	1,566.0	1,566.0	1,566.3	0.3
E	3,995	65	314	9.6	1,586.2	1,586.2	1,586.9	0.7
F	5,250	119	390	7.7	1,614.2	1,614.2	1,614.2	0.0
G	5,895	170	429	7.0	1,630.1	1,630.1	1,631.1	1.0
H	6,685	43	227	13.2	1,650.4	1,650.4	1,651.2	0.8

[1] Feet above confluence with Willowemoc Creek

TABLE 2

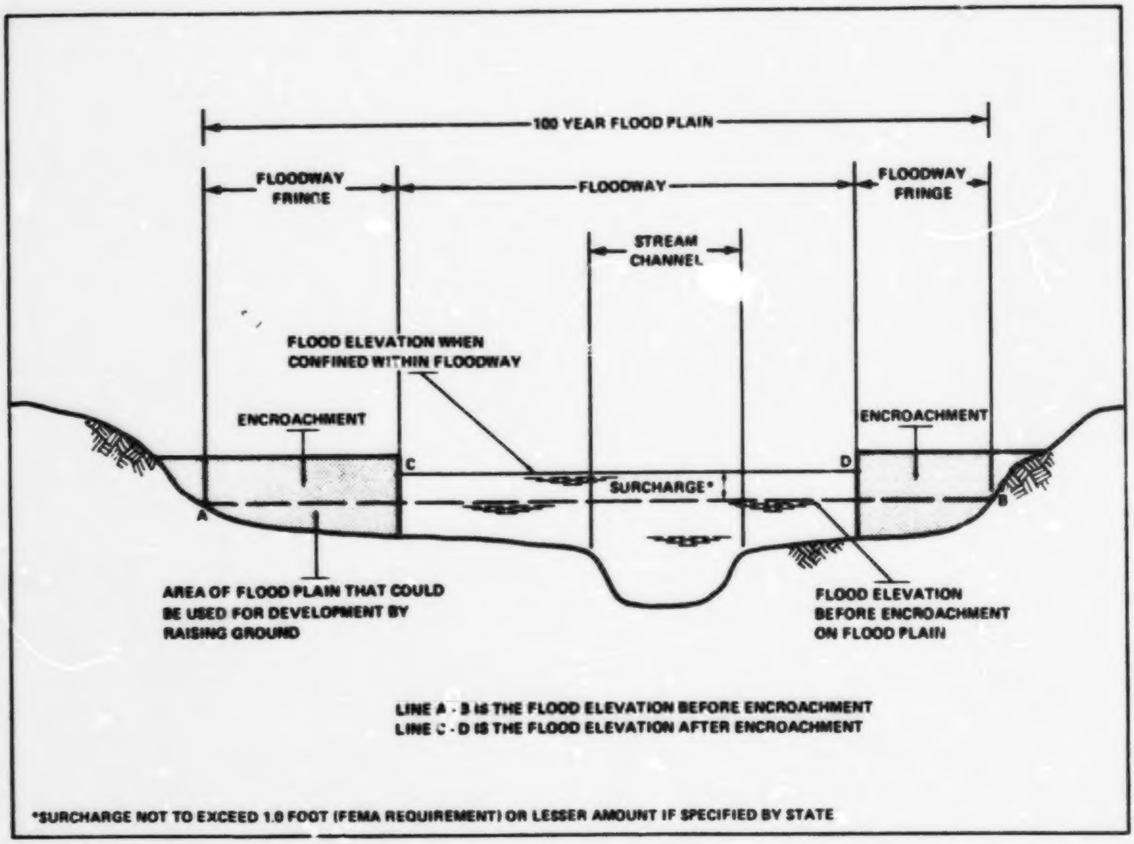
FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY

(SULLIVAN CO.)

FLOODWAY DATA

LITTLE BEAVER KILL - SPRAGUE BROOK


100 YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE A - B IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE C - D IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE

FLOODWAY SCHEMATIC

Figure 2

5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail in the Town of Rockland.

5.1 Reach Determinations

Reaches are defined as sections of flood plain that have relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following tabulation for more than 20 percent of the reach:

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Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the flooding sources of the Town of Rockland are shown on the Flood Profiles (Exhibit 1) and are summarized in Table 3.

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one-half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF, and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined.
Zone AO:	Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths are between 1.0 and 3.0 feet; depths are shown but no FHFs are determined.

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Willowemoc Creek							
Reach 1	36,38	-4.1	-1.3	+3.2	040	A8	Varies
Reach 2	36,37, 38	-5.7	-1.9	+3.7	055	A11	Varies
Reach 3	37,41, 43	-4.1	-1.3	+2.9	040	A8	Varies
Reach 4	41	-5.1	-1.7	+4.0	050	A10	Varies
Reach 5	41,42, 43	-2.7	-0.8	+1.8	025	A5	Varies
Reach 6	42	-4.1	-1.3	+2.6	040	A8	Varies
North of Willowemoc Creek from approximately 800 feet upstream of Broad Street to approximately 1,000 feet downstream of Broad Street	38		Ponding Area			AH	1,286

---

[1] Flood Insurance Rate Map Panel

[2] Weighted Average

[3] Rounded to the nearest foot - see map

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY

(SULLIVAN CO.)

FLOOD INSURANCE ZONE DATA

WILLOWEMOC CREEK

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND 10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)	FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
Beaver Kill Reach 1	36,38	-2.9	-1.0	+1.8	030	A6	Varies
Stewart Brook Reach 1	38	-1.3	-0.4	+0.7	015	A3	Varies
Cattail Brook Reach 1	43	-2.0	-0.6	+1.5	020	A4	Varies
Little Beaver Kill Reach 1	43,44	-2.1	-0.6	+1.2	020	A4	Varies
North of Little Beaver Kill from Grove Street to approximately 1,250 feet downstream of Grove Street	43	Sheet Flow Area - Average Depth 2 Feet				AO	--

[1] Flood Insurance Rate Map Panel
[2] Weighted Average
[3] Rounded to the nearest foot - see map

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO.)

FLOOD INSURANCE ZONE DATA

BEAVER KILL - STEWART BROOK - CATTAIL BROOK - LITTLE BEAVER KILL

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Little Beaver Kill (continued) North of Little Beaver Kill from approximately 1,040 feet upstream of Grove Street to Grove Street	43	Sheet Flow Area - Average Depth 3 Feet				AO	--
Sprague Brook Reach 1	41,42	-1.7	-0.5	+1.0	015	A3	Varies

[1] Flood Insurance Rate Map Panel

[2] Weighted Average

[3] Rounded to the nearest foot - see map

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY

(SULLIVAN CO.)

FLOOD INSURANCE ZONE DATA

LITTLE BEAVER KILL - SPRAGUE BROOK

Zone AH:	Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths are between 1.0 and 3.0 feet; base flood elevations are shown, but no FHFs are determined.
Zones A3, A4, A5, A6, A8, A10, and A11:	Special Flood Hazard Areas inundated by the 100-year flood; with base flood elevations shown, and zones subdivided according to FHFs.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- or 500-year floods by dike, levee, or other water control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flooding; not subdivided.

Flood elevation differences, FHFs, flood insurance zones, and base flood elevations for the flooding sources studied in detail in the community are shown in Table 3.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the Town of Rockland is, for insurance purposes, the principal result of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevations. Base flood elevation lines show the locations of the expected whole-foot water-surface elevation of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the National Flood Insurance Program.

6.0 OTHER STUDIES

No previous flood studies have provided detailed water-surface elevations for Rockland. There have been several previous flood related reports pertaining to Rockland and the surrounding Sullivan County area. A report by the USGS documented peak flows and gage heights on Willowemoc Creek and Little Beaver Kill (Reference 3). Also, the COE prepared a report of flood protection in the Rockland area in 1954 (Reference 4).

Flood Insurance Studies for the Towns of Callicoon, Hardenburgh, and Neversink have been completed (References 13, 14, and 15). The results of this study are in exact agreement with the results of those studies.

The Flood Insurance Study for the Town of Liberty is currently being prepared (Reference 16). The results of that study will be in exact agreement with the results of this study.

Due to a more detailed analysis, this Flood Insurance Study supersedes the Flood Hazard Boundary Map for Rockland (Reference 17).

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, Regional Director, Region II Office, 26 Federal Plaza, Room 1347, New York, New York 10278.

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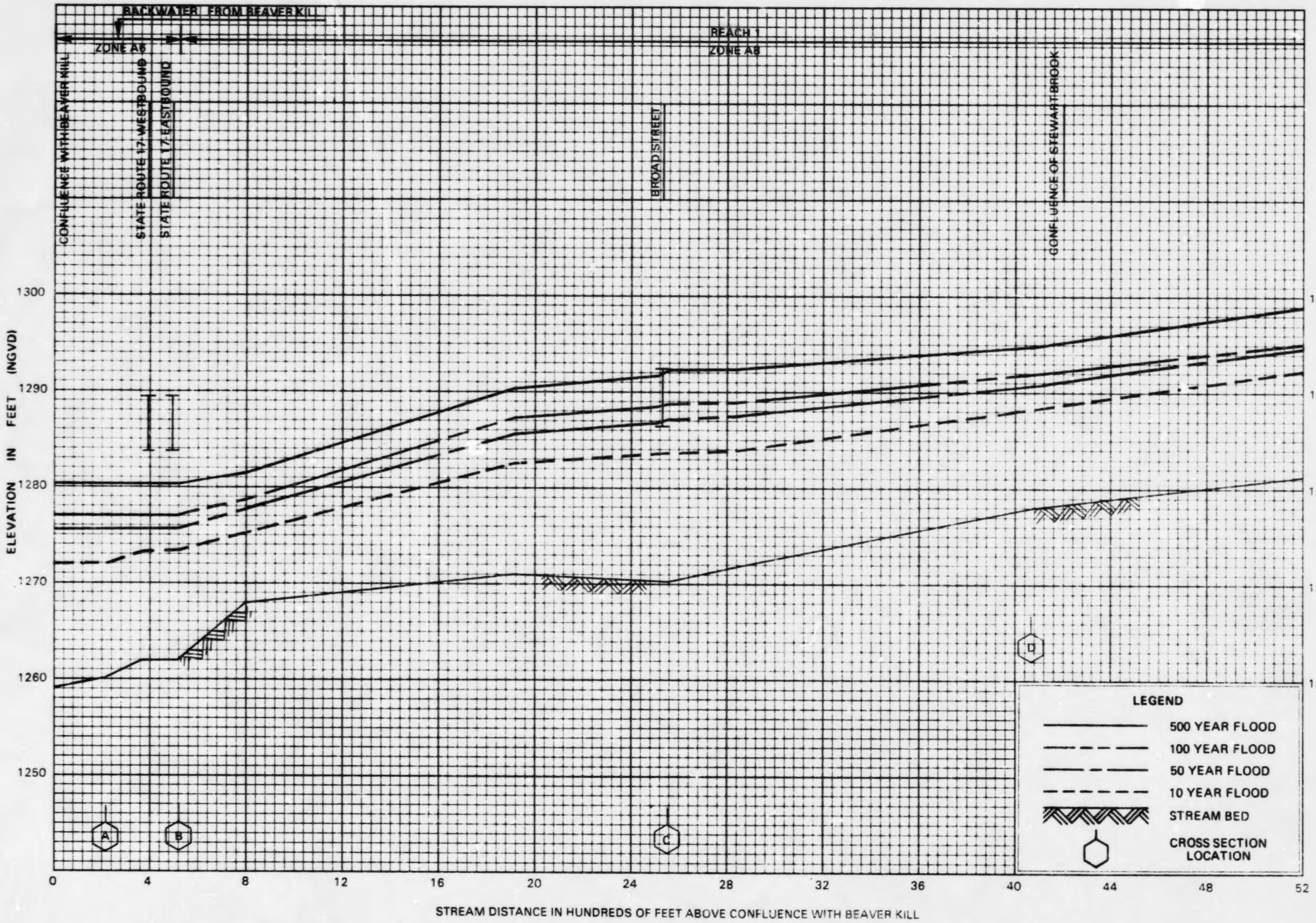

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO.)

FLOOD PROFILES

WILLOWEMOC CREEK

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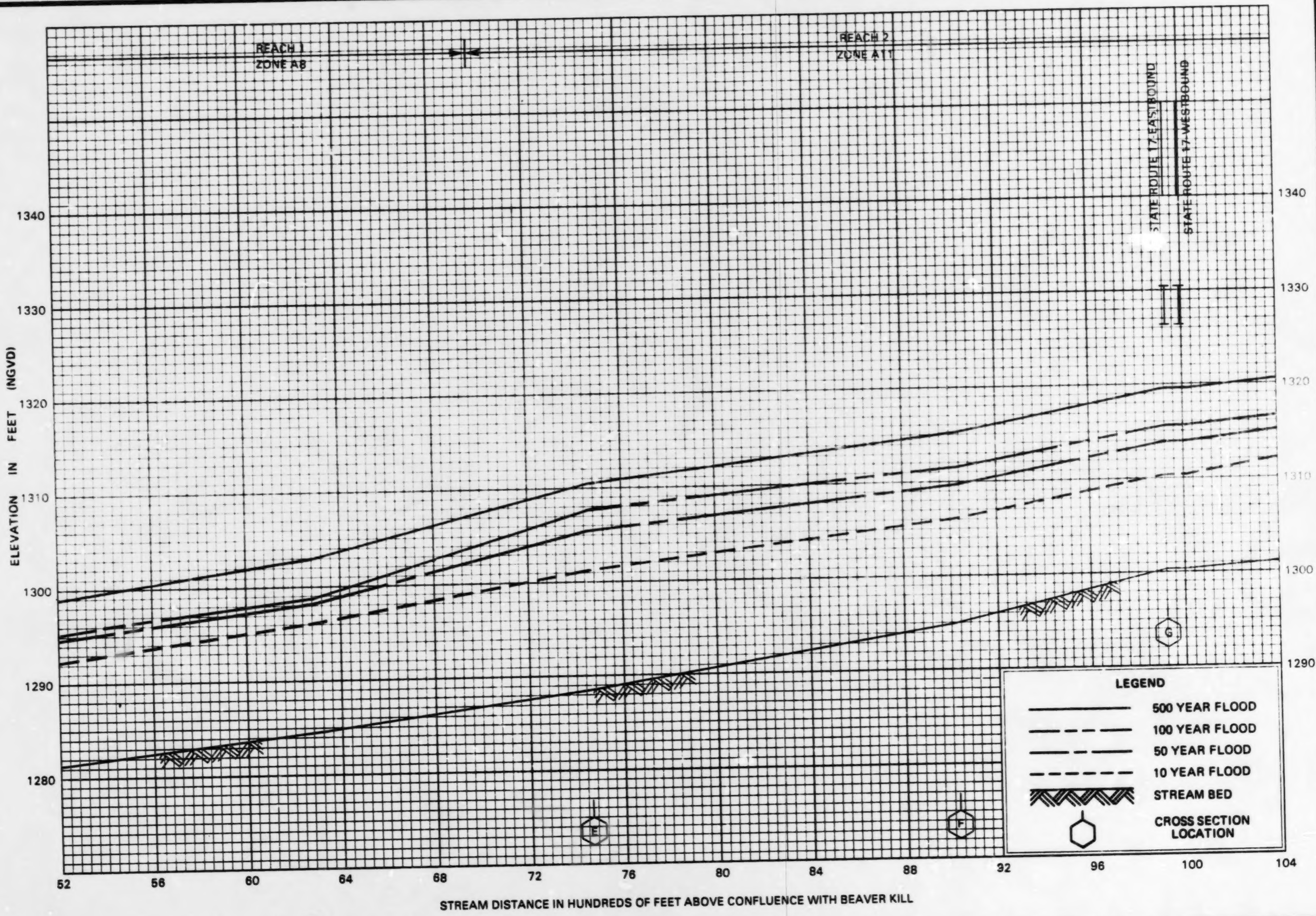

FLOOD PROFILES

WILLOWEMOC CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO.)

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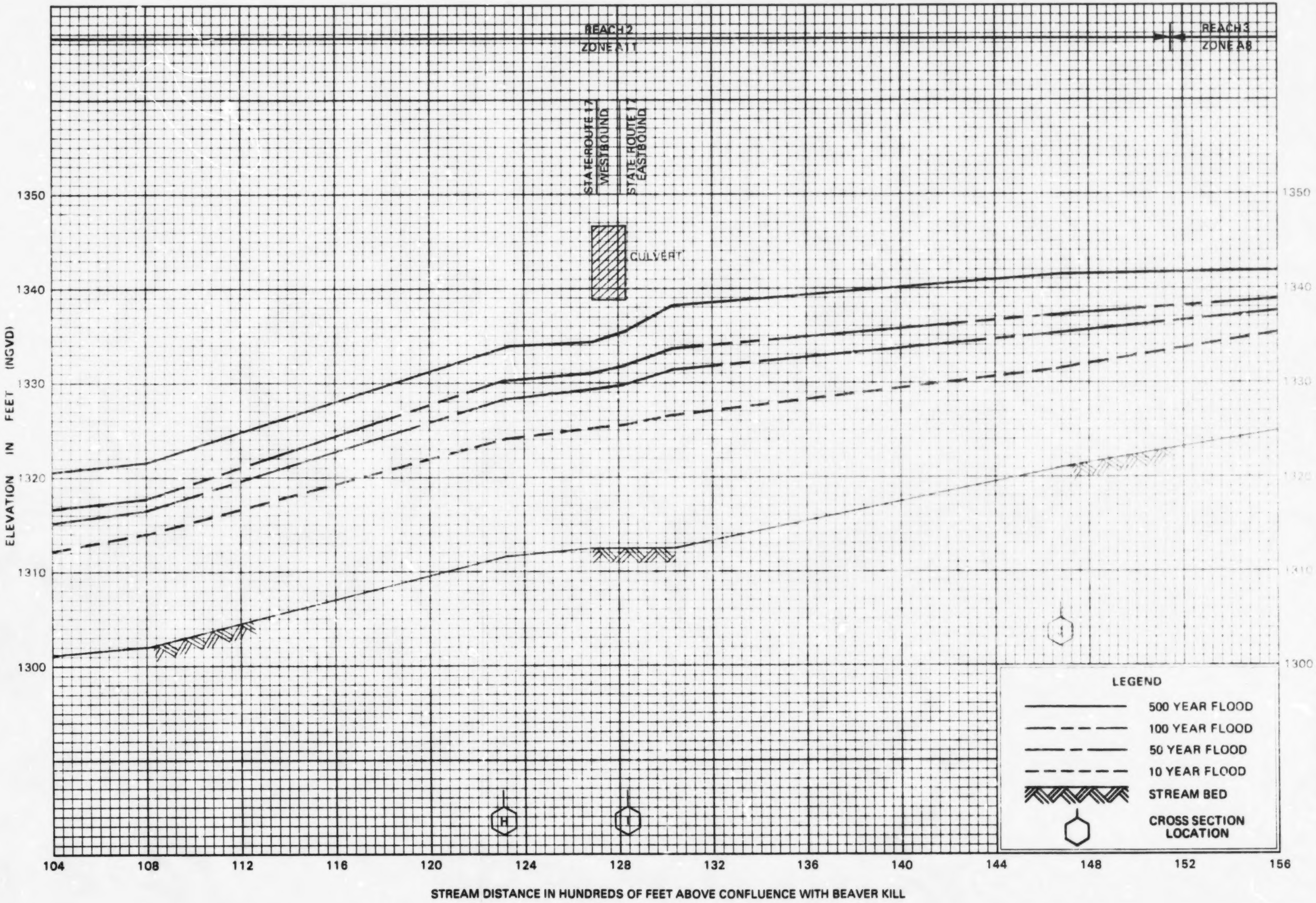

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO.)

FLOOD PROFILES

WILLOWEMOC CREEK

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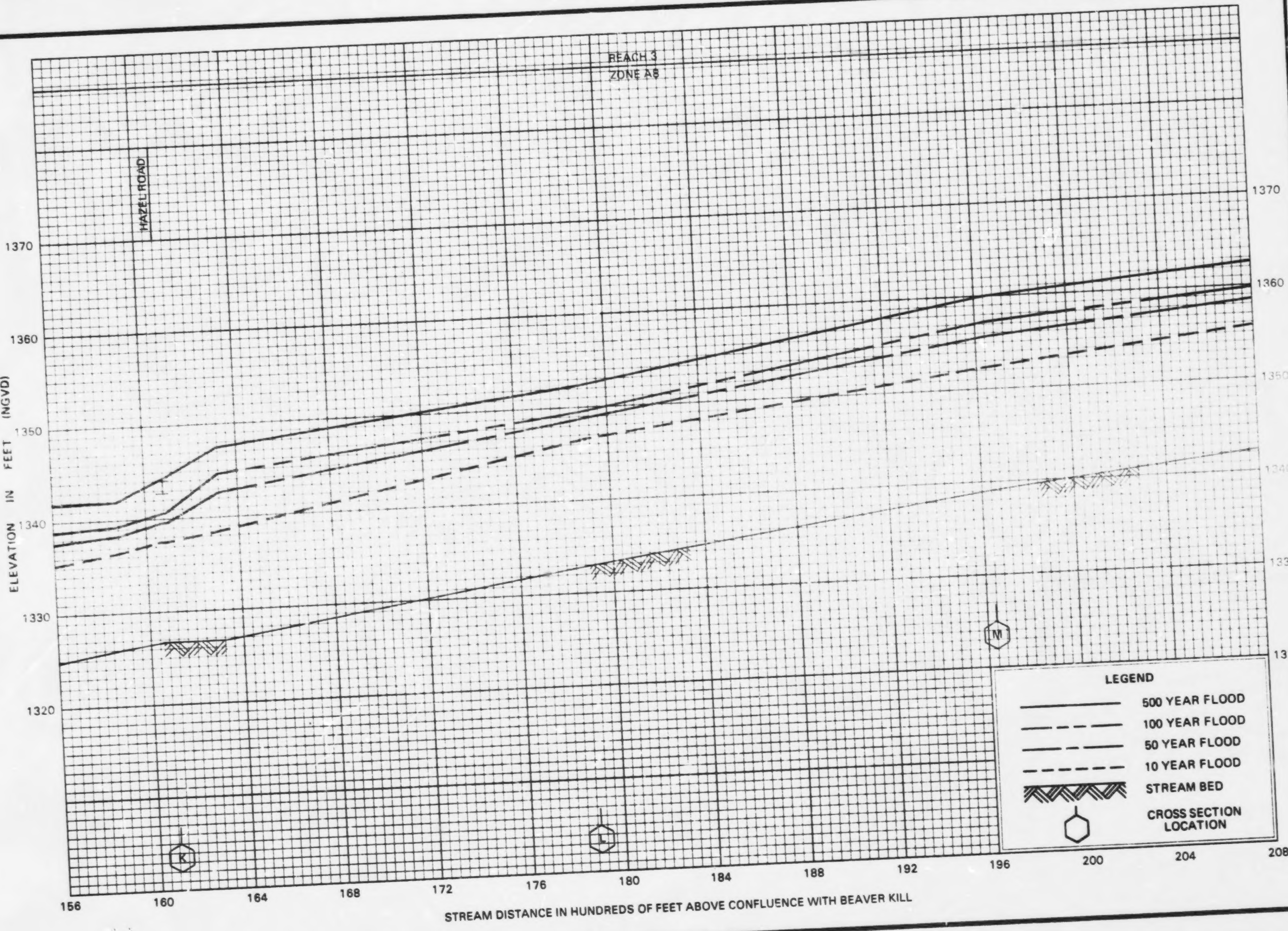

FLOOD PROFILES

WILLOWEMOC CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO.)

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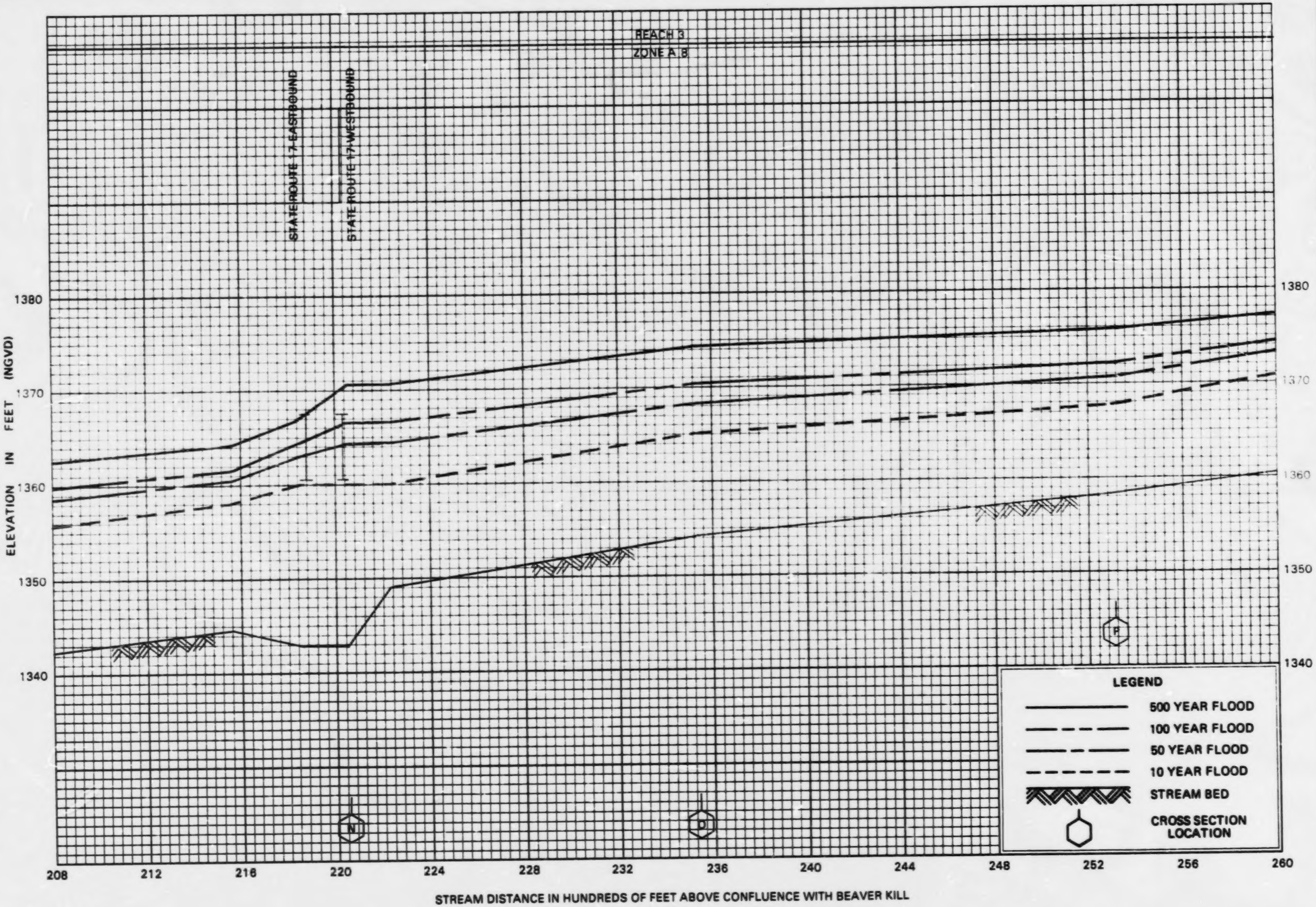

FLOOD PROFILES

WILLOWEMOC CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY

(SULLIVAN CO.)

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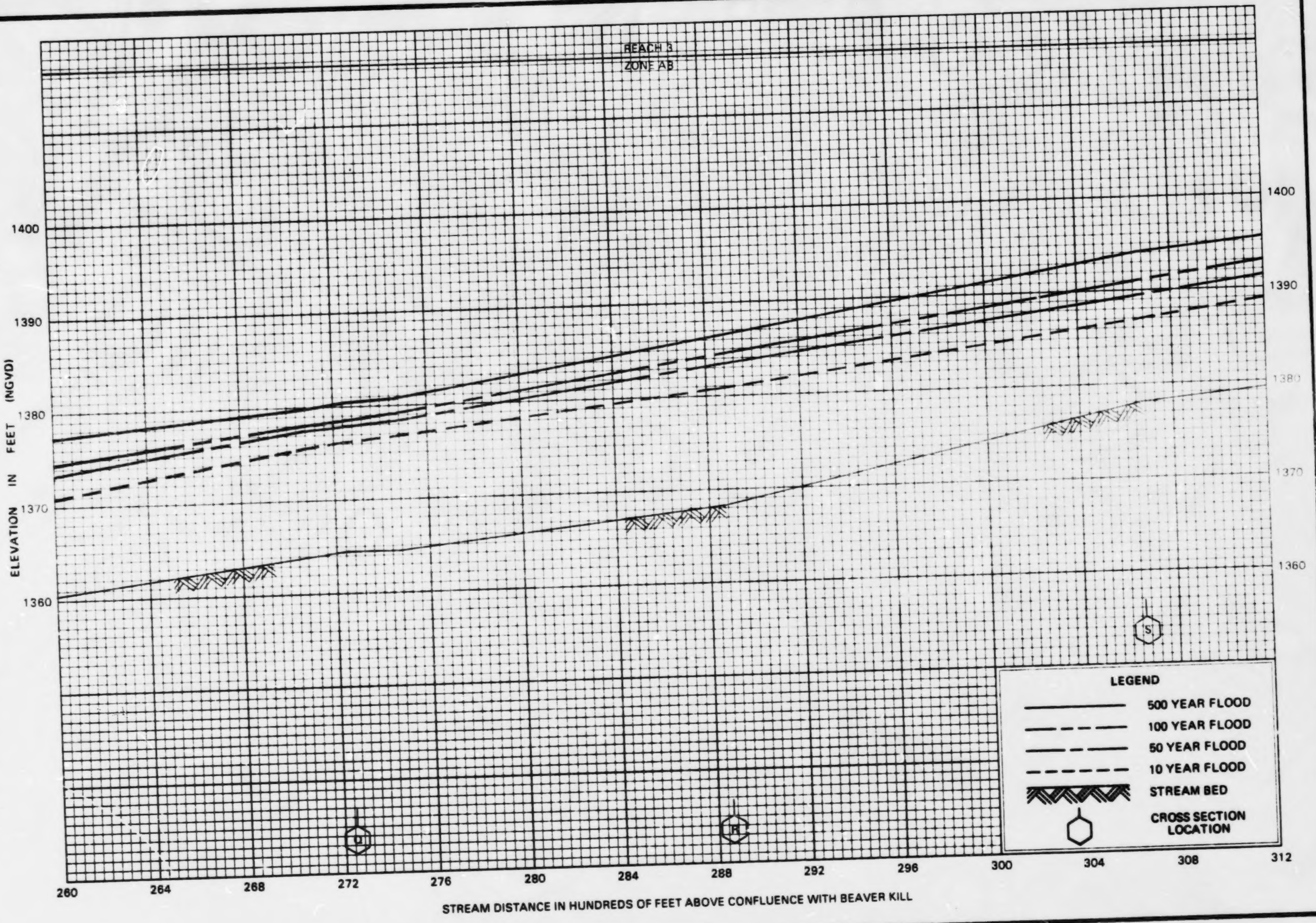

FLOOD PROFILES

WILLOWEMOC CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO.)

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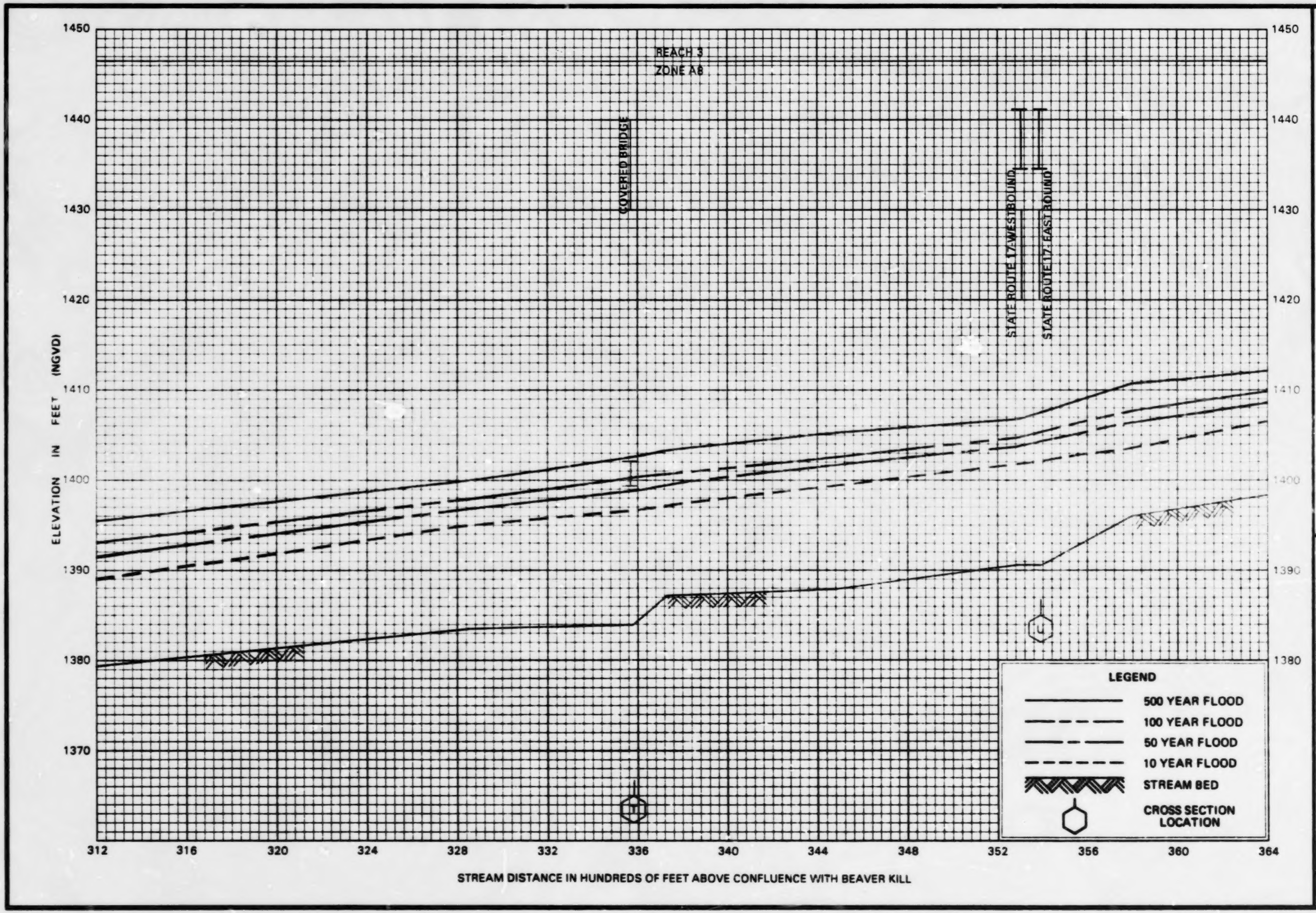

FLOOD PROFILES

WILLOWEMOC CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO.)

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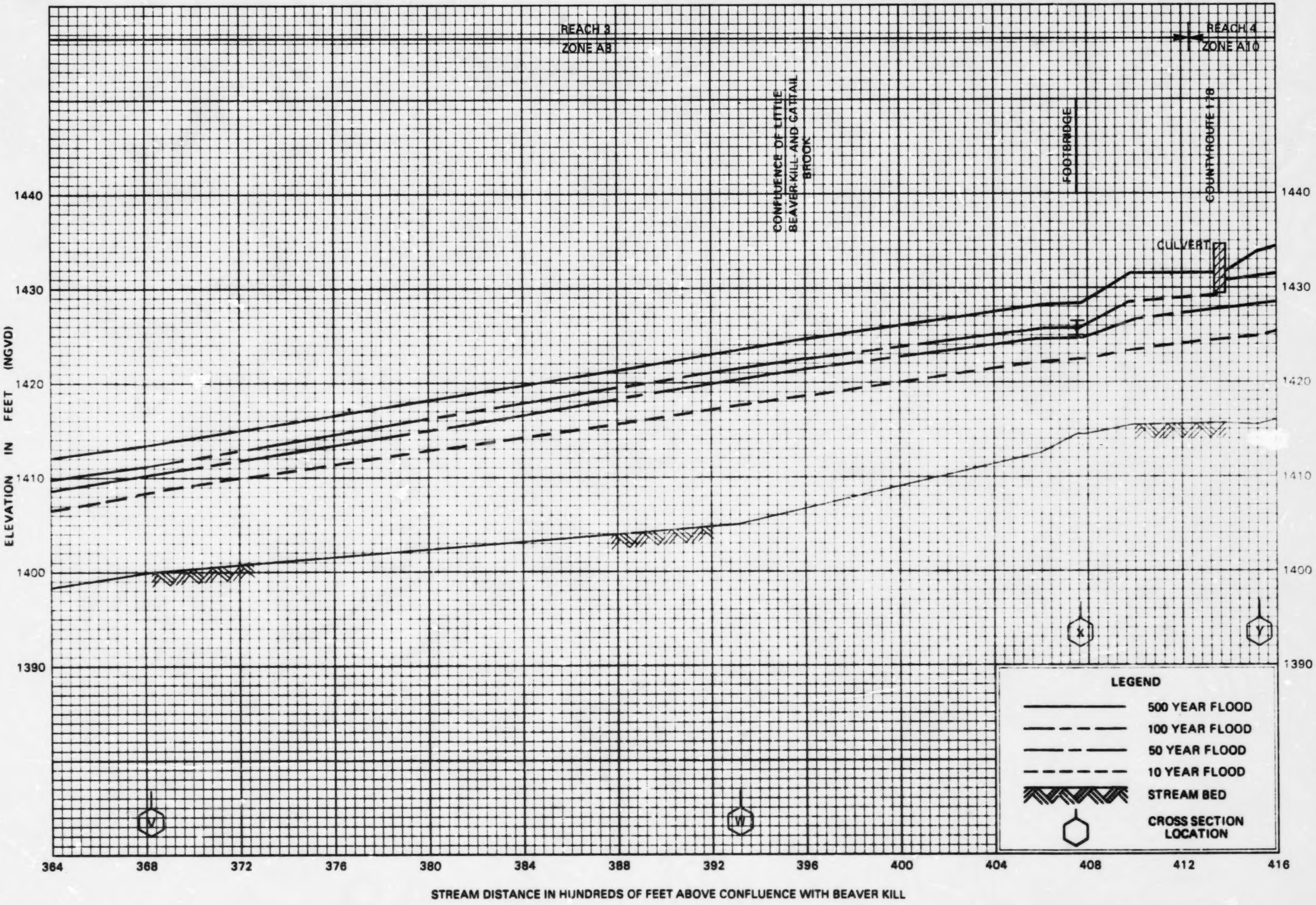

FLOOD PROFILES

WILLOWEMOC CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO.)

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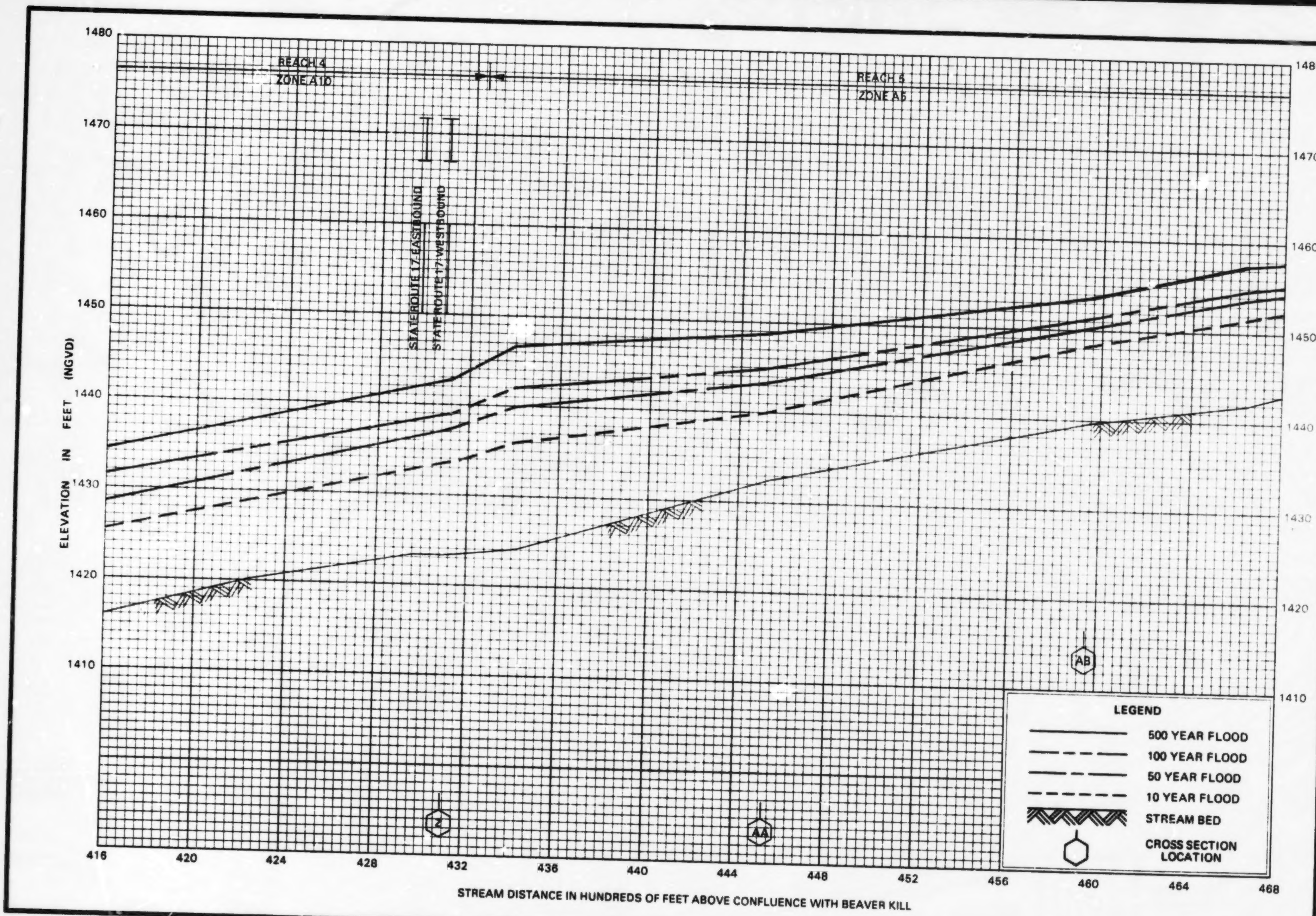

FLOOD PROFILES

WILLOWEMOC CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO.)

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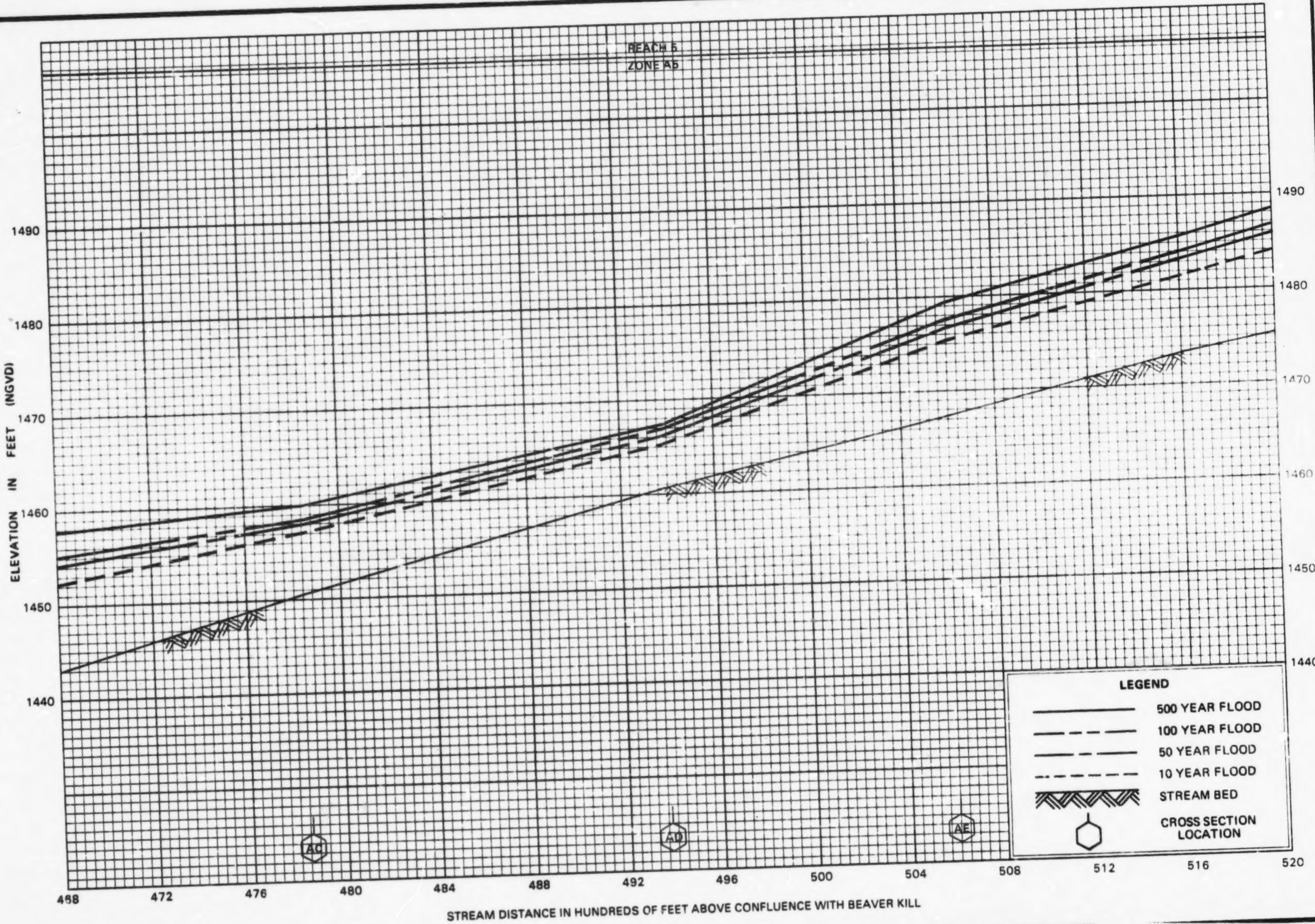

FLOOD PROFILES

WILLOWEMOC CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO.)

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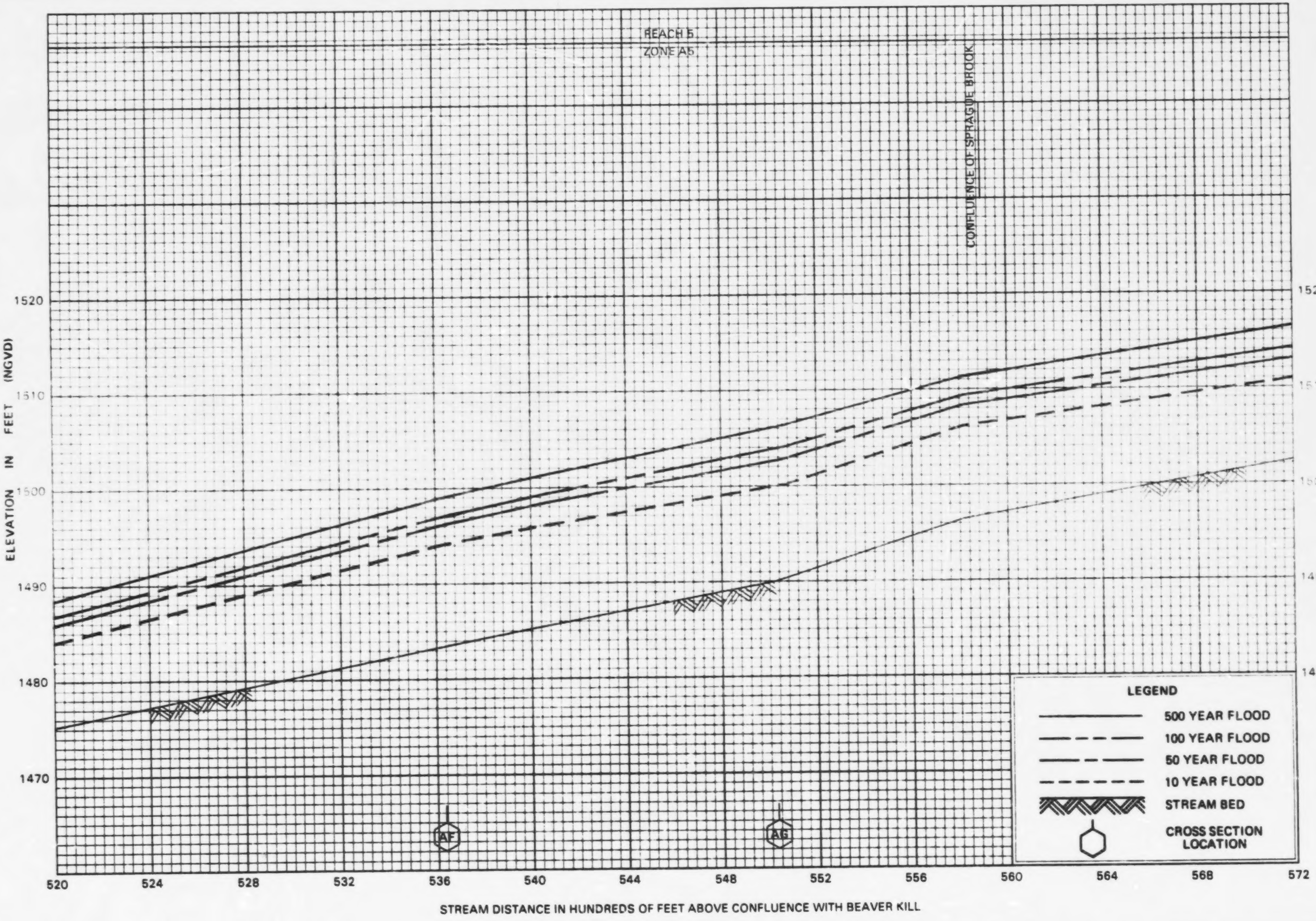

FLOOD PROFILES

WILLOWEMOC CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO.)

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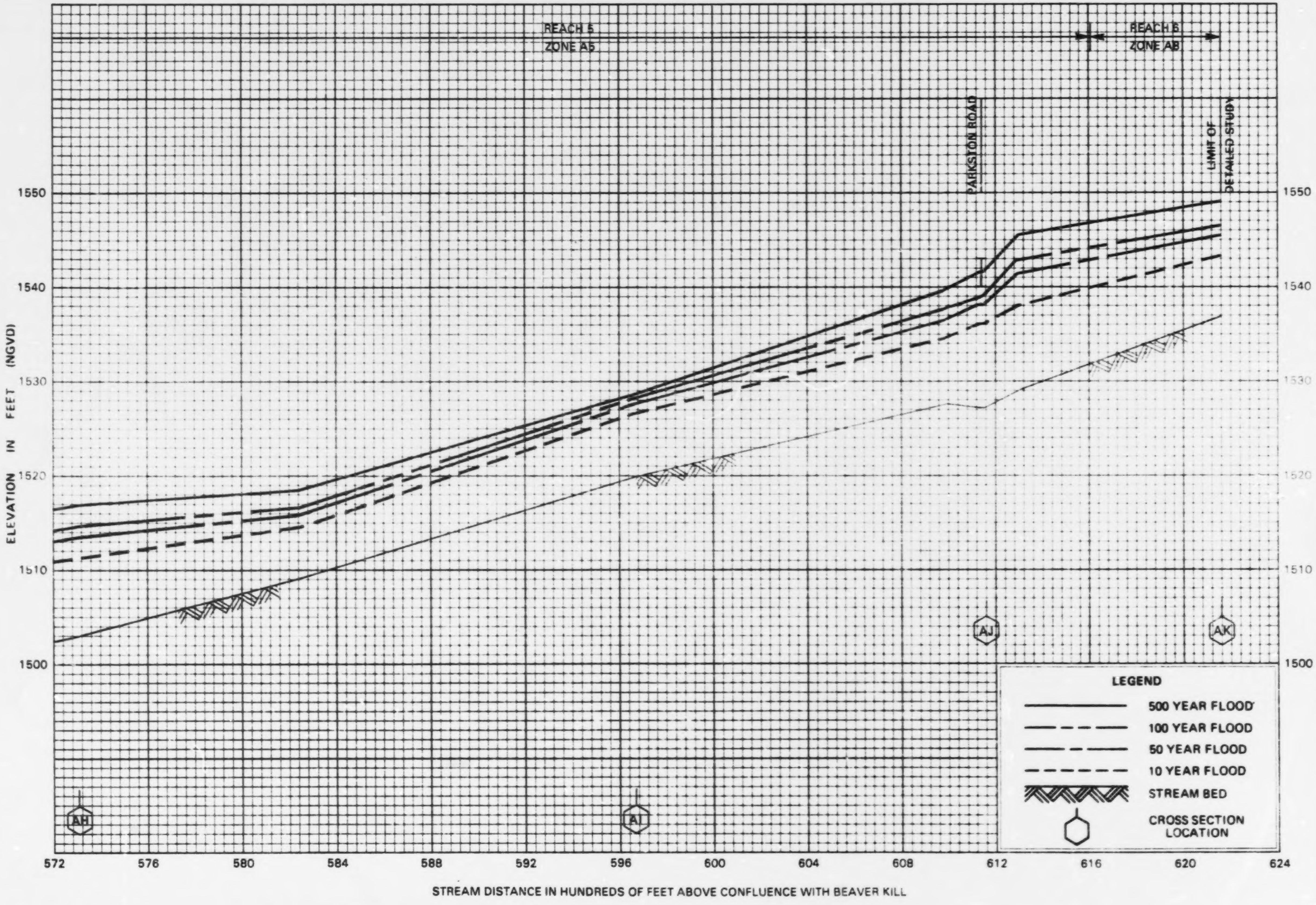

FLOOD PROFILES

WILLOWEMOC CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO.)

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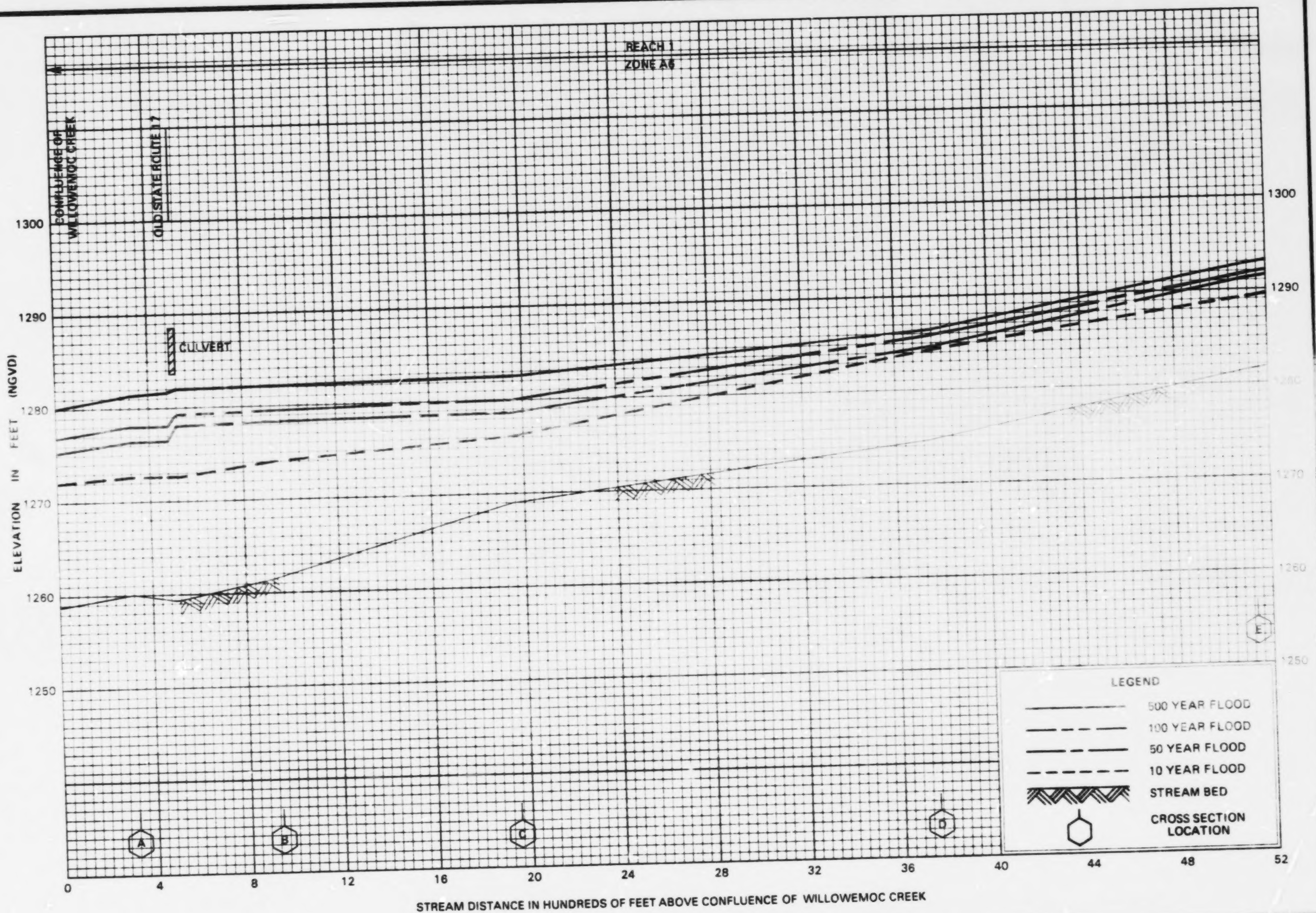

FLOOD PROFILES

BEAVER KILL

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO.)

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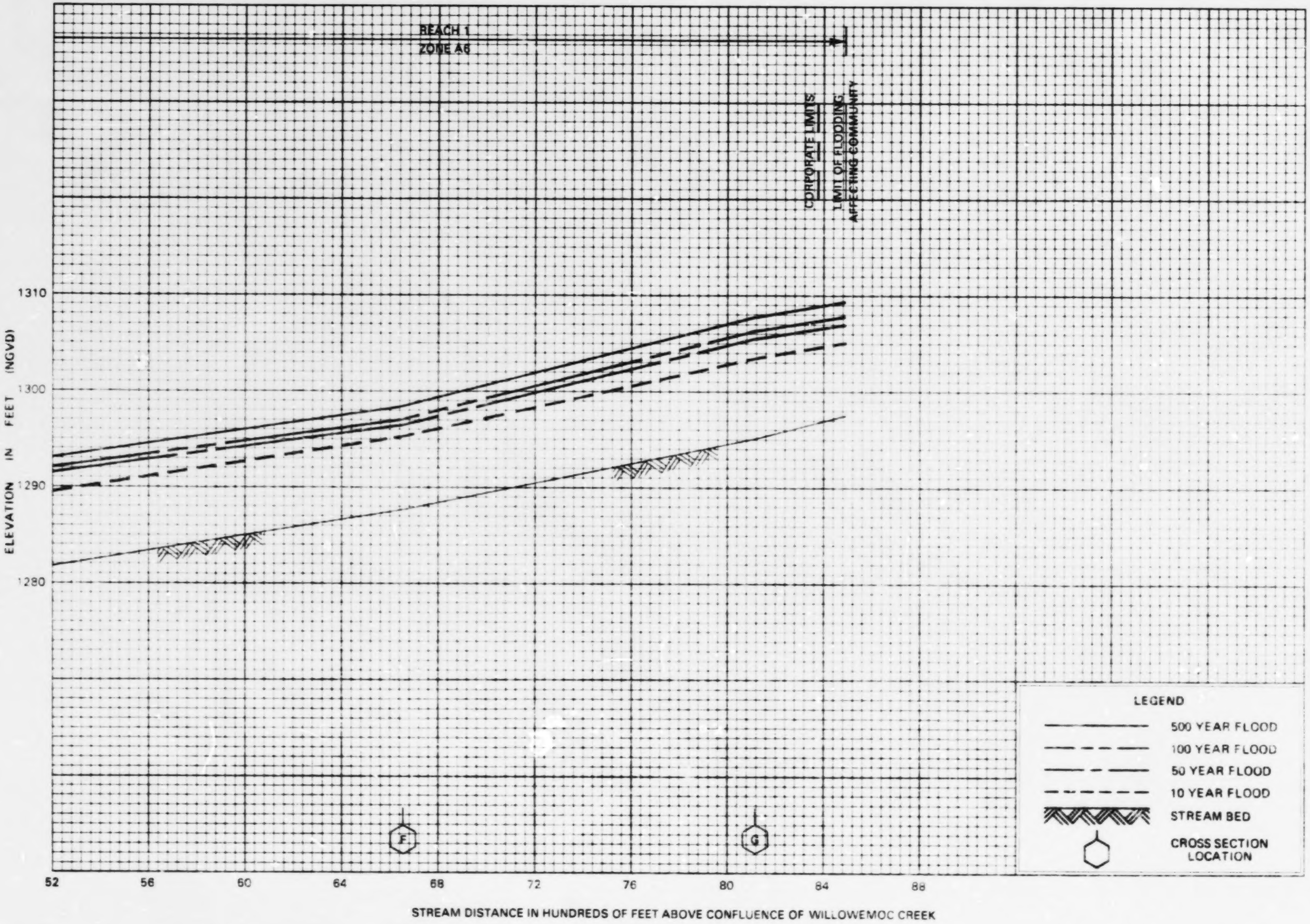

FLOOD PROFILES

BEAVER KILL

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO)

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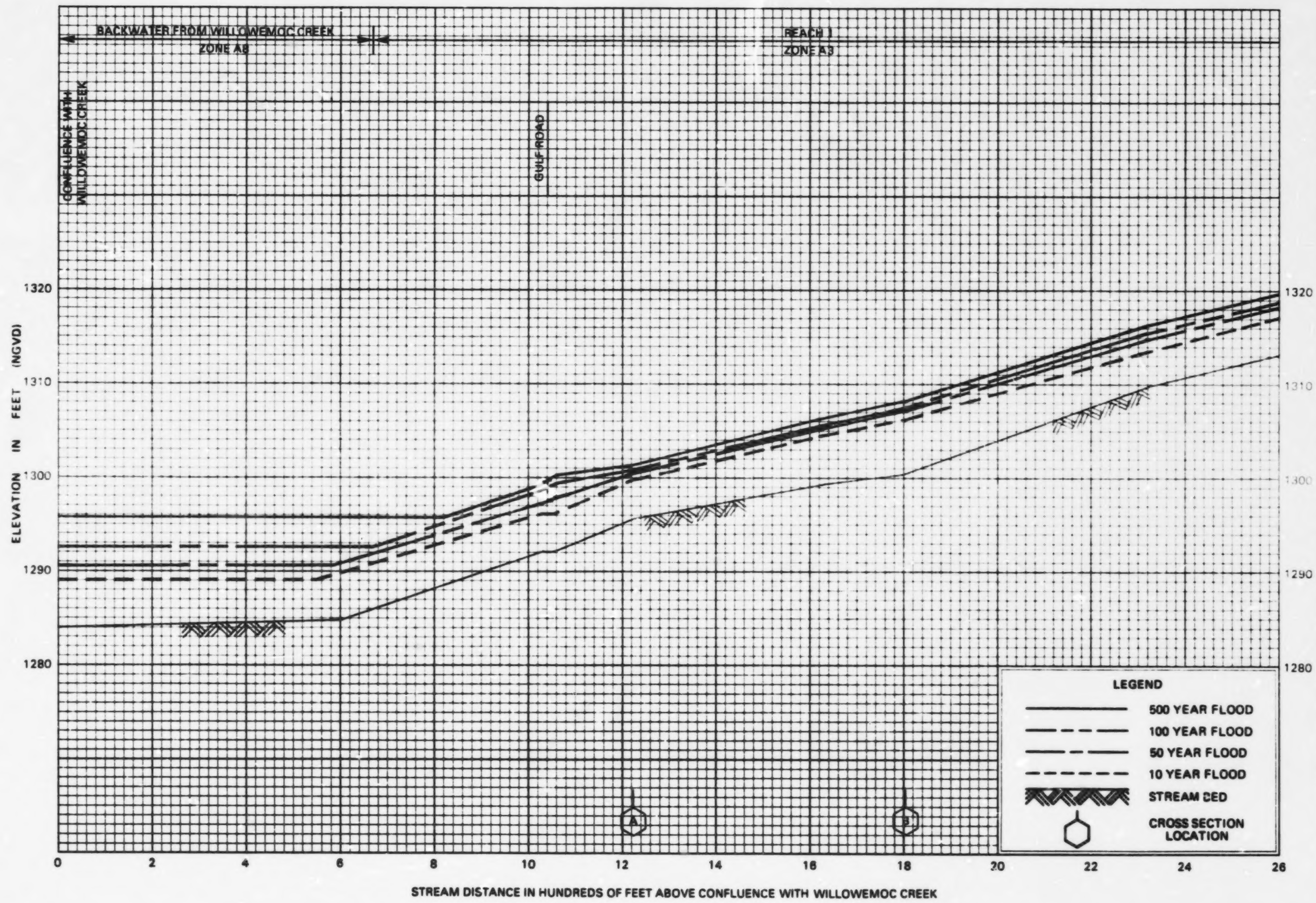

FLOOD PROFILES

STEWART BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY

(SULLIVAN CO.)

15P

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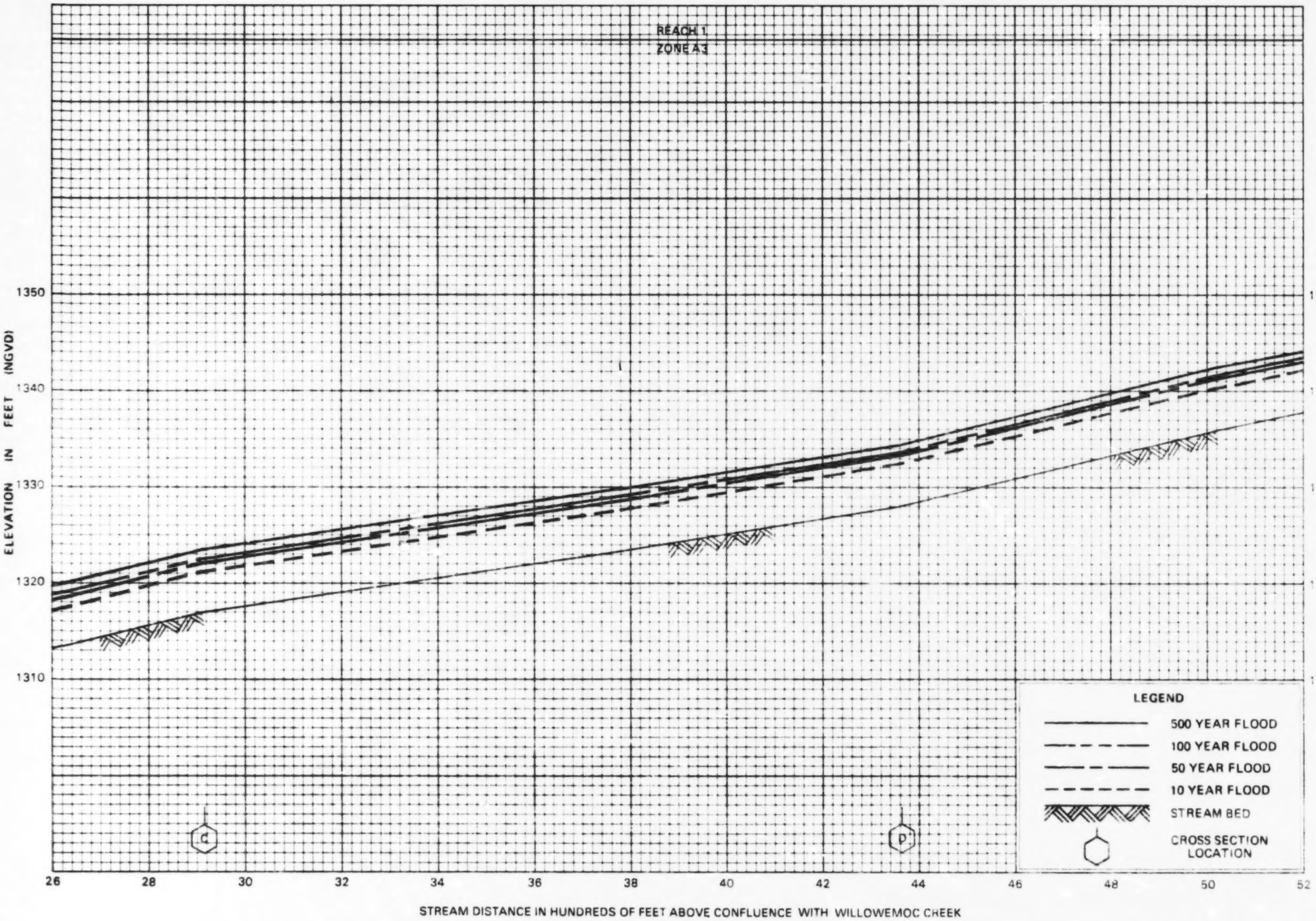

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STEWART BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO.)

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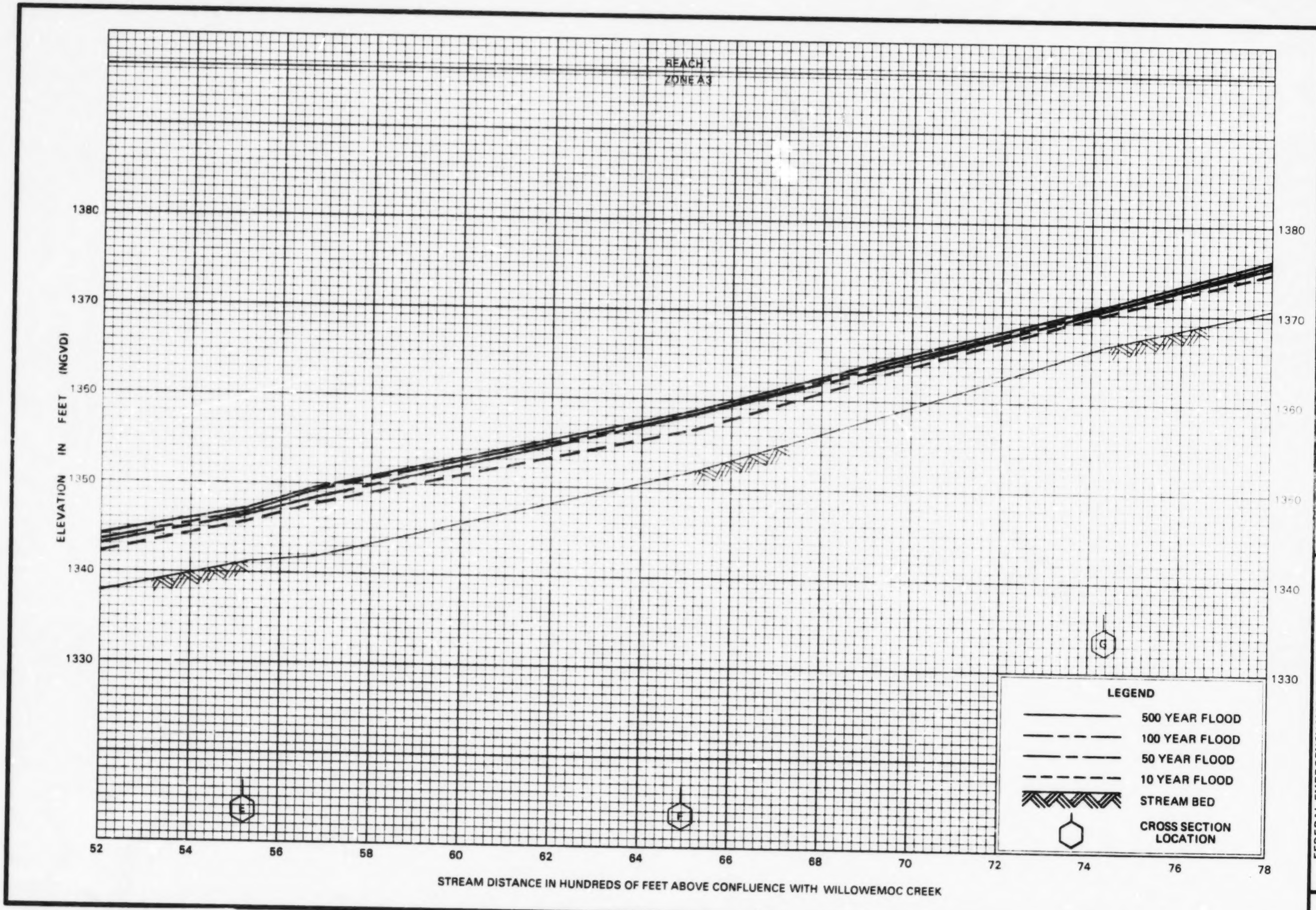

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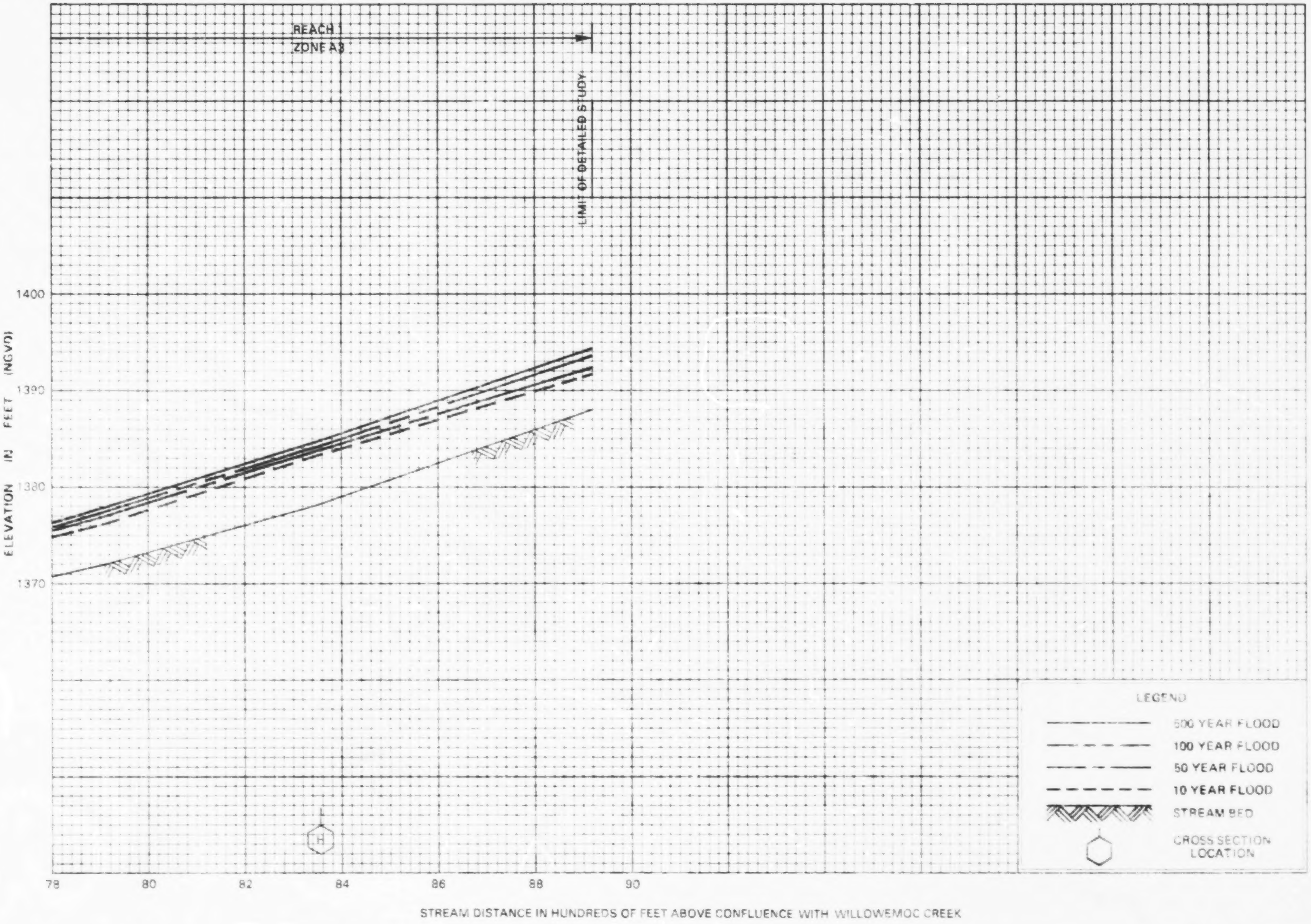

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TOWN OF ROCKLAND, NY
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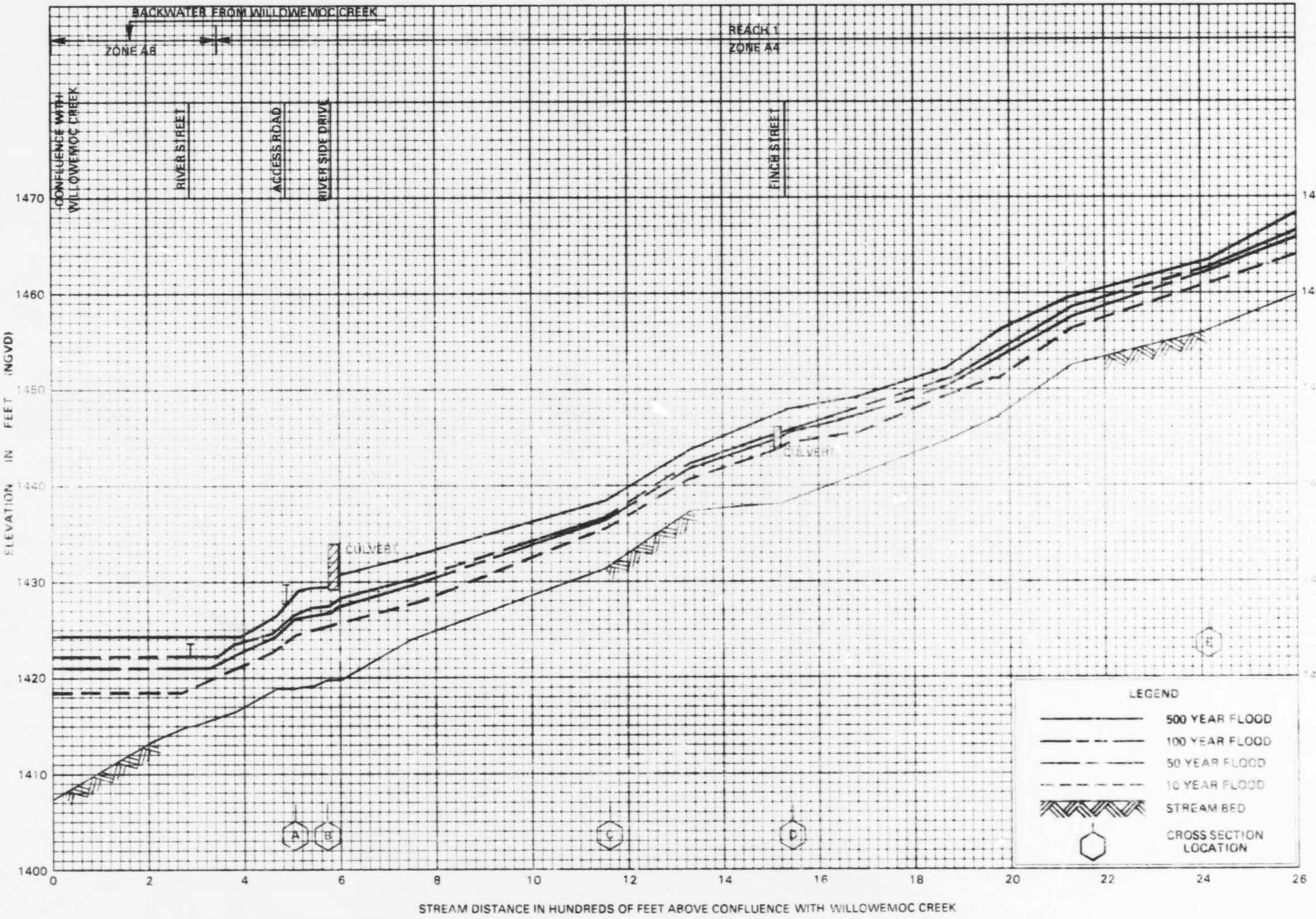

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CATTAIL BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO)

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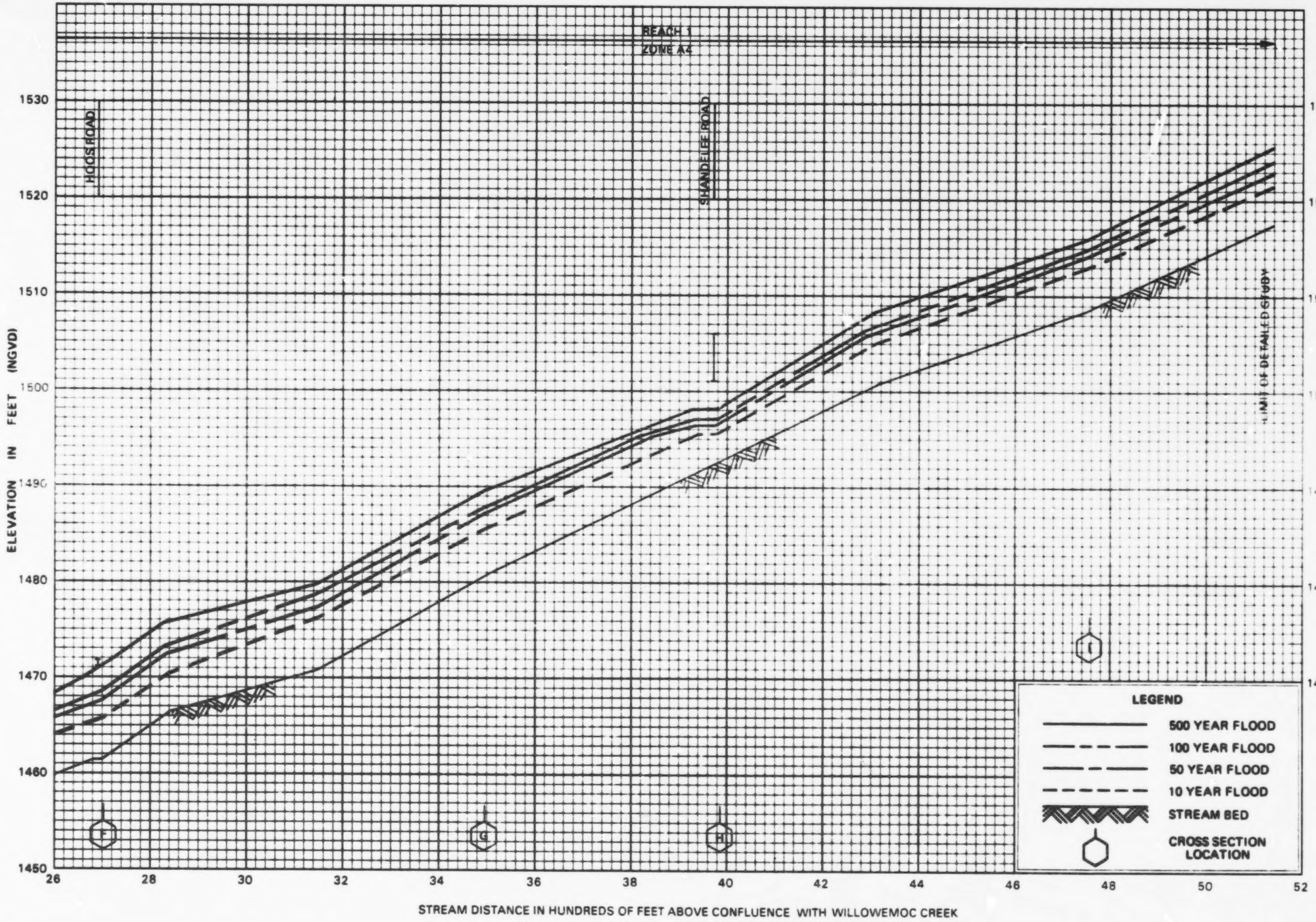

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CATTAIL BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO.)

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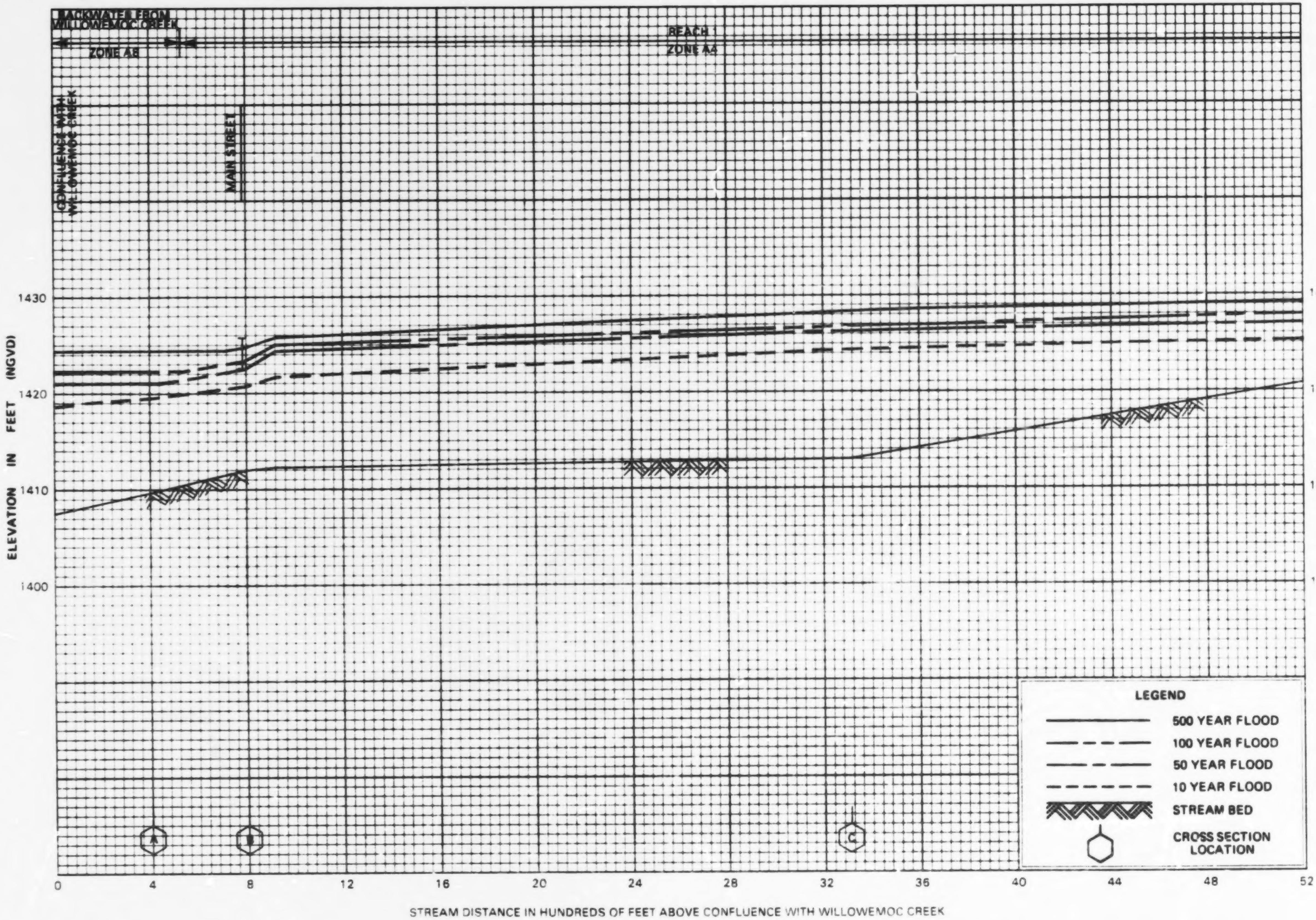
43



FLOOD PROFILES

LITTLE BEAVER KILL

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO.)

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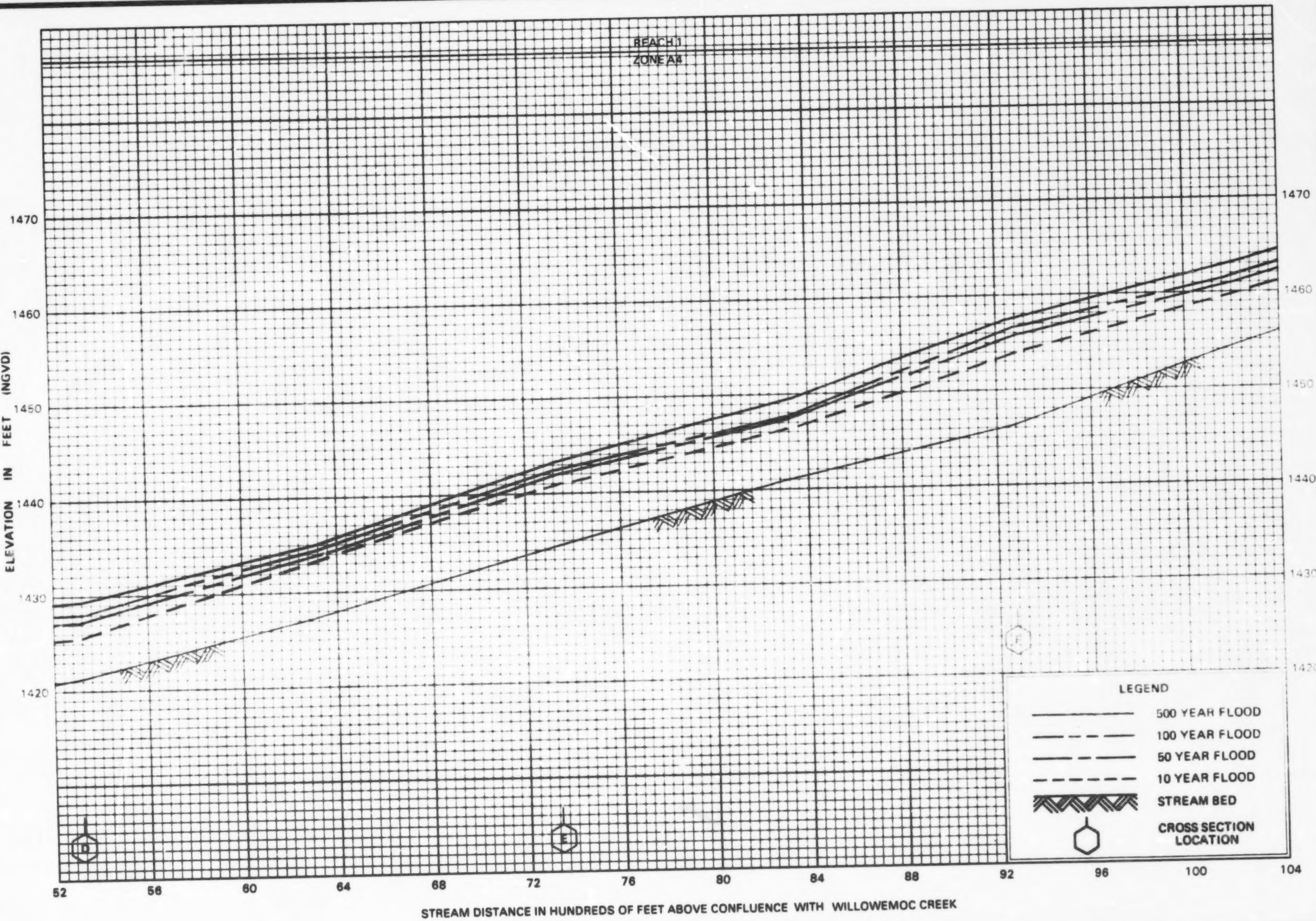

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LITTLE BEAVER KILL

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO)

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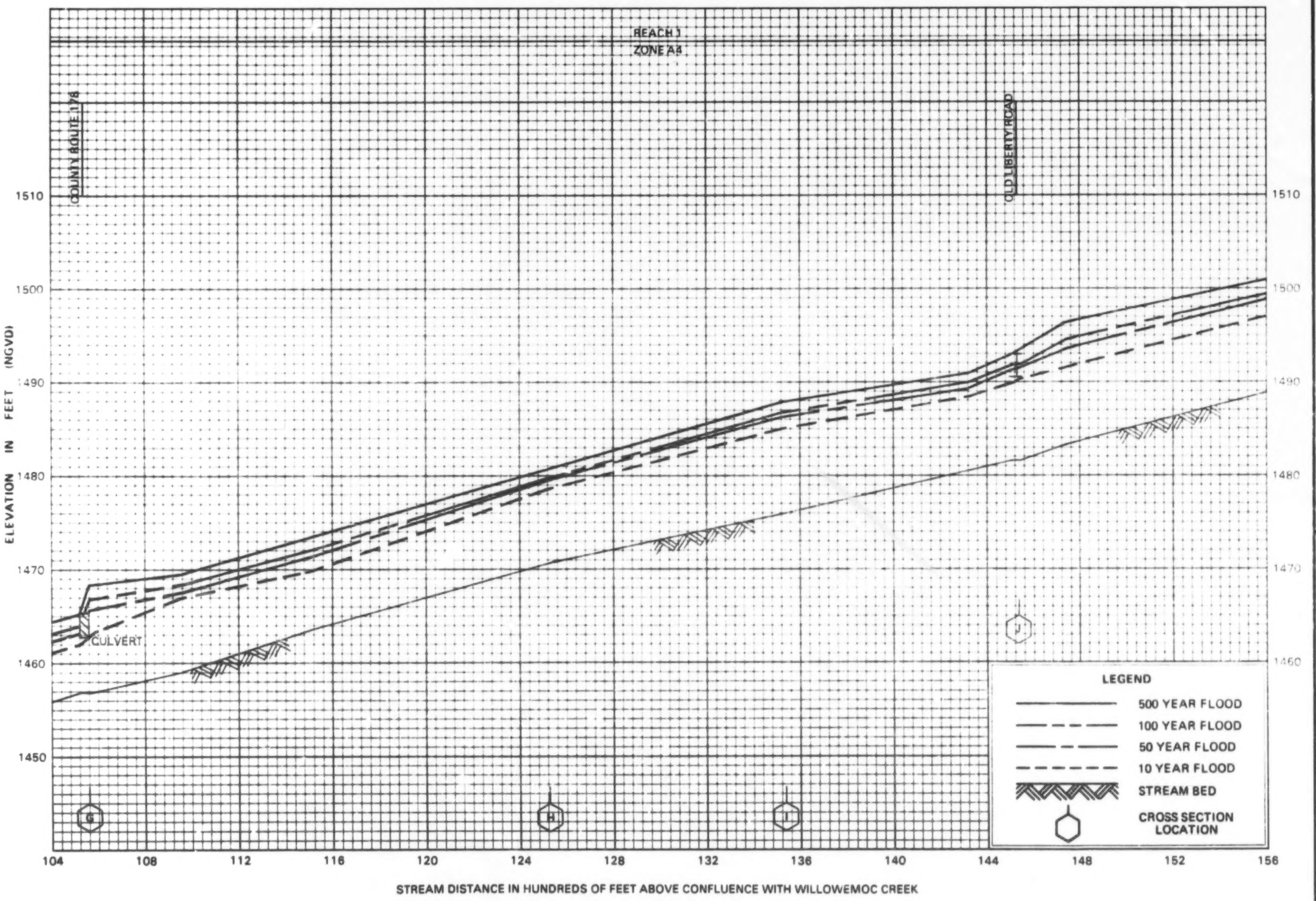

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LITTLE BEAVER KILL

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO.)

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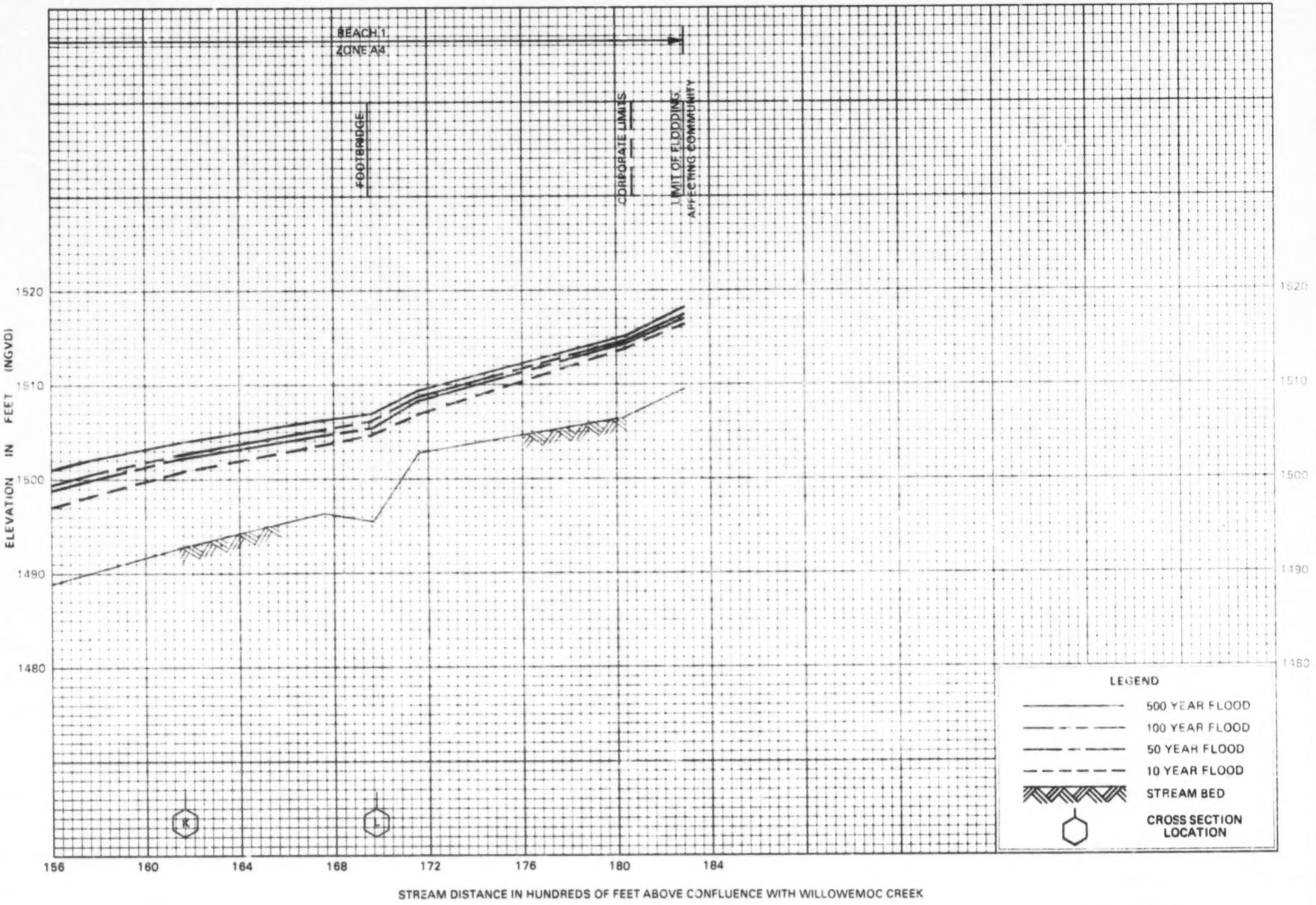

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LITTLE BEAVER KILL

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO.)

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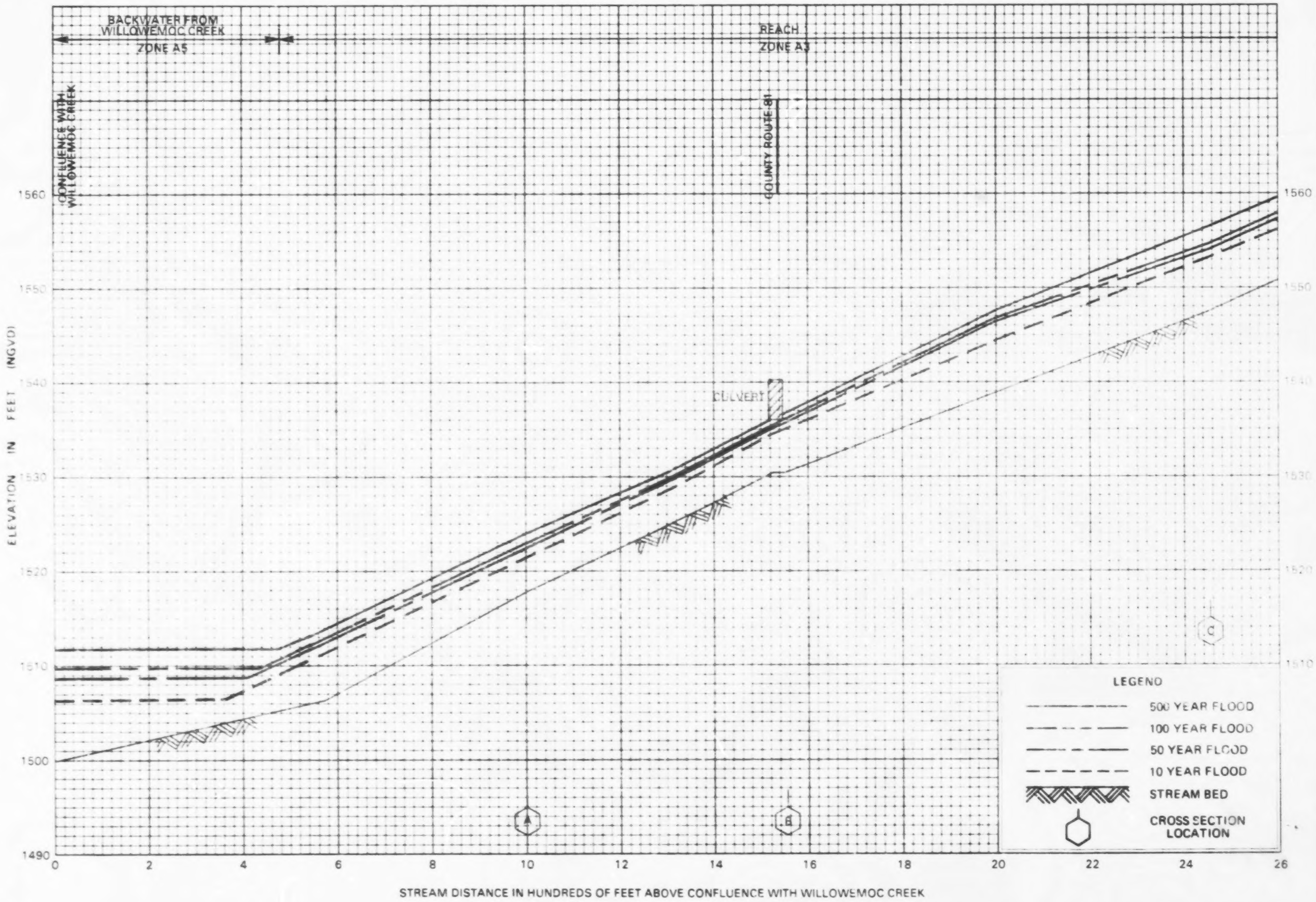

FLOOD PROFILES

SPRAGUE BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO.)

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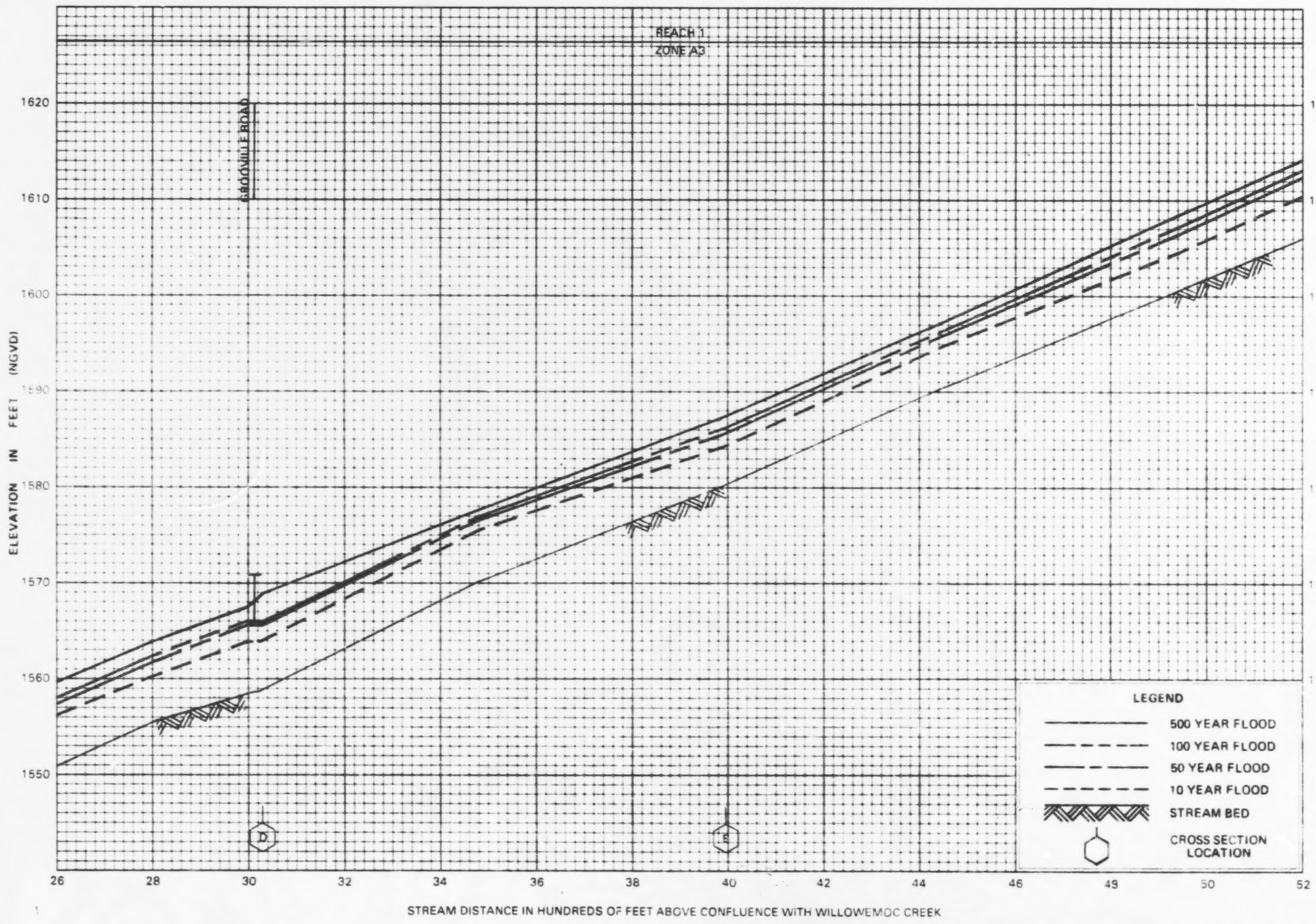

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SPRAGUE BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ROCKLAND, NY
(SULLIVAN CO.)

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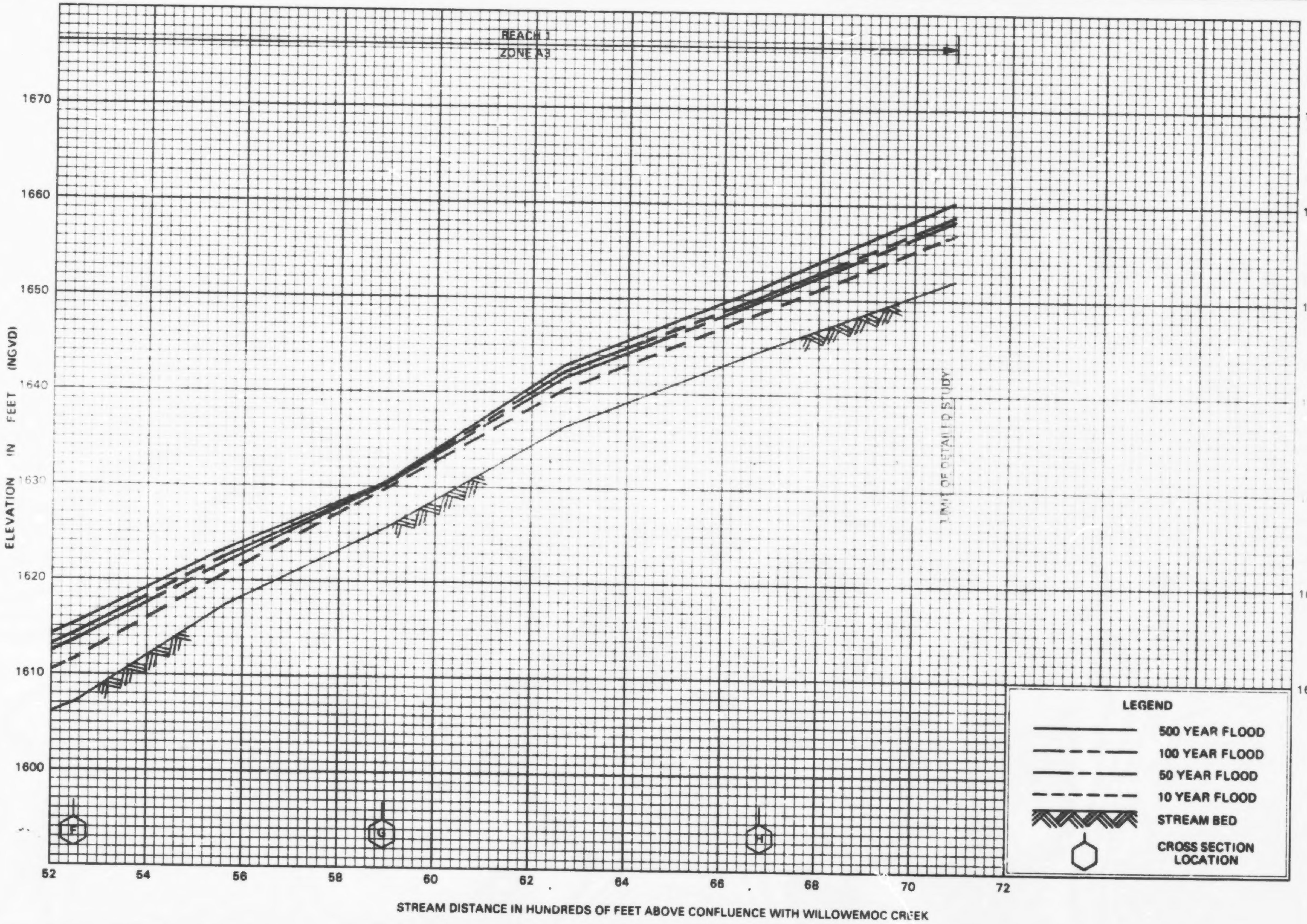

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SPRAGUE BROOK

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